

**MINISTRY OF RAILWAYS
GOVERNMENT OF INDIA**

**TECHNICAL SPECIFICATIN
FOR
220kV OR 132kV OR 110kV OR 66kV or 25kV
POTENTIAL TRANSFORMER**

**SPECIFICATION No.
TI/SPC/PSI/PT/0200**

**ISSUED BY
RESEARCH DESIGN & STANDARD ORGANISATION
MANAK NAGAR, LUCKNOW-226011**

DRAFT

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Specification No. TI/SPC/PSI/PT/0200
POTENTIAL TRANSFORMERS, 220 kV or 132 kV or 110 kV or 66 kV or 25kV

1. SCOPE

- 1.1** This specification applies to outdoor type single phase, oil immersed 220kV or 132kV or 110kV or 66kV (Type-I & II), or 25kV Potential transformers (PT) to be installed at unattended/attended railway traction substations/substations/switching stations for operation of protective devices, metering and indication.
- 1.2** The potential transformers shall be completed with all parts and accessories necessary for their efficient operation. All such parts and accessories shall be deemed to be within the scope of this specification, whether specifically mentioned or not.
- 1.3** ~~This specification supersedes the specification No. ETI/PSI/35 (4/75), ETI/PSI/56 (3/80) AND ETI/PSI/000) which were meant for 132kV, 66kV and 25kV potential Transformer respectively, while this specification has been prepared to cater the need of potential Transformer for system voltages of 220k, 132kV, 110kV, 66kV or 25kV, latest modification/test suggested by IS:3156-1992 have been incorporated in this specification. Hence, the equipment approved (includes prototype approval) as per either of these above superseded specifications, shall be considered as approved as per this specification also. This specification is a combined specification for all type of PTs, used in traction distribution system.~~ **This specification supersedes the specification No. TI/SPC/PSI/PTs/0990 which was meant for 220kV, 132kV, 110kV, 66kV and 25kV potential Transformer.**
- 1.4** The PT shall be erected by the purchaser/Indian Railways. However, in case a defect/deficiency noticed, the manufacturer/successful tenderer will have to depute his engineer for necessary remedial action without any cost to the Railways.

2. SERVICE CONDITIONS:

The potential transformers are intended for use in normally polluted moist tropical climate and in areas subject to heavy rain and lightning in India. The maximum ambient temperature may reach 50° c in shade, the daily maximum average ambient in shade reaching 40°c, with maximum humidity up to 100%.

The potential transformers are required to be used for connection between phase conductors and earth of a 220kV or 132kV or 110kV or 66kV or 25kV three phase or one phase system with neutral effectively earthed, for operation of protection schemes and for connection to metering/indicating instruments.

3.0 GOVERNING SPECIFICATION:

3.1 In the preparation of this specification assistance have been derived from the following standards and code of practice (latest version) and Indian Electricity Rules wherever applicable.

1.	IS : 5-2007 (REAFFIRMED 2017)	:	COLOURS FOR READY MIXED PAINTS AND ENAMELS
2.	IS : 335-2018	:	New insulating oils
3.	1271 : 2012 (REAFFIRMED 2017)	:	ELECTRICAL INSULATION-THERMAL EVALUATION AND DESIGNATION
4.	IS 1367: 2014	:	TECHNICAL SUPPLY CONDITIONS FOR THREADED STEEL

		FASTENERS
5.	IS 1554 : PART 1 : 1988 (REAFFIRMED 2015)	PVC INSULATED (HEAVY DUTY) ELECTRIC CABLES FOR WORKING VOLTAGES UPTO AND INCLUDING 1100 V
6.	IS 1570 : PART 5 : 1985 (REAFFIRMED 2018)	STAINLESS AND HEAT-RESISTING STEELS
7.	IS 1866 : 2017	MINERAL INSULATING OILS IN ELECTRICAL EQUIPMENT SUPERVISION AND MAINTENANCE GUIDANCE
8.	IS 2062 : 2011 (REAFFIRMED 2016)	HOT ROLLED MEDIUM AND HIGH TENSILE STRUCTURAL STEEL
9.	IS 3024 : 2015	GRAIN ORIENTED ELECTRICAL STEEL SHEET AND STRIP
10.	IS 4146: 1983 (REAFFIRMED 2016)	APPLICATION GUIDE FOR VOLTAGE TRANSFORMERS
11.	IS 4253 : PART 2 : 2008 (REAFFIRMED 2019) :	CORK AND RUBBER
12.	IS 5561 : 2018	ELECTRIC POWER CONNECTORS
13.	IS 10028 : PART 1 to 3 : 1985 (REAFFIRMED 2016)	CODE OF PRACTICE FOR SELECTION, INSTALLATION AND MAINTENANCE OF TRANSFORMERS
14.	IS:16227-PART 3-2015	ADDITIONAL REQUIREMENTS FOR INDUCTIVE VOLTAGE TRANSFORMERS
15.	IS/IEC 60269 : PART 1 : 2014	LOW-VOLTAGE FUSES
16.	IS/IEC 60270 : 2000 (REAFFIRMED 2016)	HIGH - VOLTAGE TEST TECHNIQUES - PARTIAL DISCHARGE MEASUREMENTS
17.	IS/IEC 62155 : 2003	HOLLOW PRESSURIZED AND UNPRESSURIZED CERAMIC AND GLASS INSULATORS FOR USE IN ELECTRICAL EQUIPMENT WITH RATED VOLTAGES GREATER THAN 1000 V

3.2 In case of any conflict between the contents of the above specification and this specification, latter shall prevail.

3.3 Any deviation from this specification, to improve the performance, utility and efficiency of equipment, proposed by the tenderer, will be given due consideration, provided, full particulars with justification thereof are furnished.

4.0 ENVIRONMENTAL CONDITIONS

4.1 The potential Transformer shall be suitable for outdoor use in moist tropical climate and in areas subject to heavy rail fall, pollution due to to industry and saline atmosphere and severe lightning. The limiting weather conditions which the equipment has to withstand in service are indicated below.

- i. Maximum ambient air temperature : 55⁰ C
- ii. Minimum Temperature of Air in shade : (-)10⁰ C
- iii. Average ambient air temperature over a period of 24 hrs. : 35° C
- iv. Maximum Relative Humidity : 100%
- v. Annual Rainfall ranging from : 1750 mm to 6250 mm
- vi. Maximum Number of Thunder storm days per annum : 85 days

- vii. Maximum number of Dust Storm days per annum : 35 days
- viii. Number of Rainy days per Annum : 120 days
- ix. Basic Wind Pressure : 200 kgf/m²
- x. Altitude above Mean Sea Level : 2000 meters

4.2 The potential Transformer would also be subjected to vibrations on account of train running on nearby railway tracks. The amplitude of these vibrations which occur with rapidly varying time periods in the range of 15 to 70 mile-second lies in the range of 30 to 150 microns at present, with the instantaneous peaks going upto 350 microns. These vibrations may become more severe as the speeds and loads of trains increase in future.

5.0 TRACTION POWER SUPPLY SYSTEM

5.1 General Scheme

5.1.1 The single phase 50Hz power supply for railway traction system at 25kV is obtained from 220/132/110/66 kV three phase grid system through a step down, single phase power transformer, the primary winding of which is connected to two of the phases the three phase effectively earthed transmission line network of the state Electrical Board or Railways. The primary voltage of the traction transformer being 220kV or 132kV or 110kV or 66kV and no load secondary voltage being 27.5kV (Nominal secondary voltage is 25kV). In order to reduce the imbalance on the three-phase grid system, the two phases of the three-phase transmission line are tapped in a cyclic order for feeding the successive traction sub-station (TSS). The distance between adjacent TSS is normally between 50km to 80km depending upon density of traffic, gradient in the section and other factors.

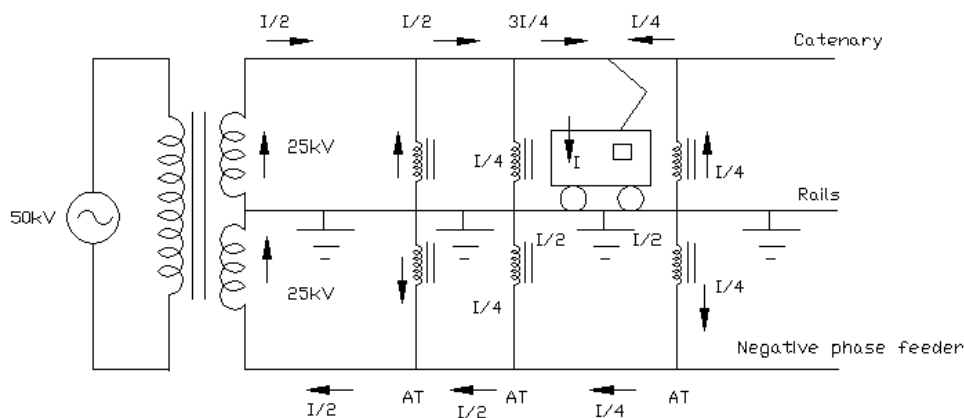
5.1.2 One terminal of the 25kV secondary winding of the traction transformer is connected to the OHE through circuit breakers/interrupters and the other terminal is solidly earthed and connected to the appropriate traction rail (s). the current flow through the OHE, to the locomotives and return conductor are provided the current returns through these the traction rail (s) and partly through the earth in the vicinity TSS. Approximately midway between two adjacent TSS a dead zone known 'neutral section' or 'phase break is provided to separate the two section of OHE by different phases. The power fed to the OHE on one side of the TSS is controlled by a feeder circuit breaker while the power fed to the OHE of each track is controlled by an interrupter. In case of fault on the OHE, the feeder circuit breaker trips isolate the faulty OHE. A schematic diagram No. **ETI/PSI/702-1** showing the general arrangement at a TSS is at **Annexure I**.

5.1.3 Normally power supply from a TSS extends upto the SP on either side of the TSS, but in case of an emergency necessitating total shut down of the sub-station, power supply from the adjacent TSS on either side of the failed sub-station can be extended upto the failed sub-station by closing the bridging interrupters at the two Sectioning & Paralleling post (SPs).

5.1.4 BRIEF DESCRIPTION OF THE 2 X 25 KV NEW SYSTEMS

To up gradation of existing NDLS-HWH and DLI-KOTA-MUMBAI ROUTES for 160kmph, the 2X25 kV new system is preferred solution across the globe to cater the higher power requirement on high density routes.

In 2x25 kV system, power is fed from the TSS at 50 kV and utilization is achieved at 25 kV by providing Auto-transformers of adequate capacity and by providing one additional conductor normally referred as feeder wire (similar to the return conductor in BT/RC system). Centre point of the Auto Transformer is connected to the earth/rail. This arrangement facilitates +25 kV Voltage between OHE and rail and -25 kV voltage between Rail/earth and the Feeder Wire. A schematic diagram No. **TI/DRG/PSI/AT/00009/20/0, TI/DRG/PSI/AT/00030/20/0 & TI/DRG/PSI/AT/00032/20/0** showing the general arrangement at a TSS is at **Annexure I-A, B & C**



5.2 NATURE OF LOAD ON THE 25kV SYSTEM

The traction load is of frequent and rapidly varying nature and fluctuates between no-load and overloads. The load cycle varies from day to day due to non-uniform pattern of traffic.

5.3 NATURE OF LOAD ON THE 25kV SYSTEM

The OHE is made up of a stranded cadmium copper catenary of 65mm² cross section or a stranded aluminum alloy catenary of 116mm² cross section and a grooved contact wire of 107mm² or 150 mm² or 210mm² copper equivalent. The OHE impedance values are generally taken as under:

- I. Single track OHE without return conductor : 0.41 / 70°C Ohm/km
- II. Double track OHE without return conductor : 0.24 / 70°C Ohm/km
- III. Single track OHE with return conductor : 0.70 / 70°C Ohm/km
- IV. Double track OHE with return conductor : 0.43 / 70°C Ohm/km
- V. Add booster transformer impedance @ 0.15 Ohms per booster transformer where these are provided.
- VI. Percentage impedance of traction transformer (12+/-0.5)% (21.6 MVA base) at 27kV.

5.4 SCHEME OF PROTECTION:

5.4.1 The scheme of protection to be provided at each of the TSS shall comprise of the following:

- (a) Protection of the 220/27 kV or 132/27 kV or 110/27 kV or 66/27 kV traction transformer installed at TSS.
- (b) Protection of the 25 kV overhead equipment.

5.4.2 The following relays/instrument shall be fed by the potential transformer of 52 kV class metering and indicating protection of transformer and feeder:

- (i.) Relays/instruments fed by protection type PT's.
 - (a) Admittance (Mho) relay for distant protection.
 - (b) Admittance (Mho) relay for wrong phase coupling.
 - (c) Voltmeter at control relay panel at TSS to indicate 220kV or 132kV or 110kV or 66kV or or 25 kV bus voltage.
 - (d) Transducer for telemetry of voltage.
- (ii.) Relays/instruments fed by protection type PT's.
 - (a) Catenary indication relay.
 - (b) Transducer for telemetry of line voltage.
- (iii.) Supply to metering.

6.0 RATING AND GENERAL DATA

6.1 The potential transformer shall be designed for the following rating and other particulars:

1	Type	:	Core type, single phase outdoor installation, immersed, Self-cooled, suitable for mounting, structural steel supports.					
2	System voltage							
	i. Nominal system Voltage kV (rms)	:	220	132	110	66	25 (for New 2x25 kV scott connected TSS only)*	25
	ii. Highest system Voltage kV (rms)	:	245	145	123	72.5	72.5	52
3	Rated frequency, Hz	:	50 ± 3%					
4	Rated Primary Voltage kV (rms)	:	220/√3	132/√3	110/√3	66/√3	25kV	25kV
			(a) 27.5 kV- where the no-load voltage of OHE and SCADA system are calibrated at 27.5kV (b) 25kV-where the existing oHE voltage having SCADA and the relevant meters for indication/protection calibrated at 25kV.					
	Rated Secondary Voltage	:	- 110 V for 220kV or 132kV or 110kV or 66kV - For 25kV (a) 100V (type I for line indication) (b) 110V ((type II for protection)					
5	Rated burden at 0.8 Power factor (VA)							
	(a) For 220kV or 132kV or 110kV or 66kV	:	30VA					
	(b) 25kV	:	(i) 30VA (For type I) (ii) 100VA (For type II)					
6	Class of insulation	:	A					
7	Rated voltage factor	:	1.2 for 30 sec					
8	Rated insulation levels							
	i. Highest system voltage kV (rms)	:	245	145	123	72.5	72.5	52
	ii. Rated power frequency Withstand voltage kV (rms)	:	395	275	230	140	140	95

	iii. Lightning impulse Withstand voltage kV (peak)	:	950	650	550	320	320	250
9	Temperature rise (temperature measured by resistance method)	:	The temperature rise over an ambient of 50°C shall not exceed the value indicated below (i.) Winding : 45°C (ii.) Oil : 35°C (iii.) Current carrying parts in air : 40°C					
10	Bushing (Porcelain Housing)							
	(i) Type	:	Single piece construction and free from ribs on the underside.					
	(ii) Highest voltage for Equipment, kV (rms)	:	245	145	123	72.5	72.5	52
	(iii) Minimum creepage distance in air, mm	:	6125	3625	3075	1813	1813	1300
11	Resistance of primary winding for 25kV PT (Type-I)	:	Not less than 27000 Ohm at 10°C for type-I PT (line indication) to avoid Ferro resonance effect					

* This rating is to be used with-in the Scott connected TSS only of 2 x25 kV system.

6.2 ACCURACY CLASS

The potential transformers of 220kV or 132kV or 110kV or 66kV shall have following accuracy as per clause of IS : 3156-1992 IS : 4146.

- (i.) For the burden varying between 25% and 100% of the rated burden and with applied primary voltage varying from 90% to 110% of the rated voltage ratio error shall not exceed +/-1% and the phase angle error +/- 30 minutes.
- (ii.) With the applied primary voltage varying from 5% to 120% of the rated voltage and with burden 25% to 100% of the rated burden at a power factor of 0.8 lagging, the ratio error shall not exceed +/-3% and the phase angle error +/- 120minutes.

The potential transformers of 25kV (Type-I & Type-II) shall have the following accuracy as follows:

- (i) For type-I, potential transformer (line indication) shall conform to accuracy class 6P of IS:3156 IS : 4146 (Part III)-1992. Relevant details are indicated below:

At rated frequency, for any voltage between 5% and 120% of the rated voltage with burdens between 25% and 100% of the rated burden at a power factor of 0.8 lagging, the voltage error and phase displacement shall not exceed +/-6% and +/- 240 minutes respectively.

- (ii) For type-II, potential transformer (protection) shall conform to accuracy class 1.0 of IS:3156 (part II)-1992 IS : 4146 and to accuracy class 3P of IS:3156 (Part II)-1992 IS : 4146. Relevant details are indicated below.

At rated frequency for any voltage between 80% and 120% of rated voltage and with burdens 25% and 100% of rated burden at a power factor of 0.8 lagging, the voltage error and phase displacement shall not exceed +/-1% and +/-40 minutes respectively.

All rated frequency, for any voltage between 5% and 120% of the rated voltage and with burdens between 25% and 100% of the rated burden at a power factor of 0.8 lagging the voltage error and phase displacement shall not exceed +/-3% and +/-120 minutes respectively.

7.0 CONSTRUCTIONAL FEATURE

- 7.1** The core shall be built up of high grade, cold rolled grain oriented, non-ageing steel laminations conforming to IS:3024, the laminations shall be coated on both sides with suitable insulation, capable of withstanding short circuit forces.
- 7.2** One terminal of the primary shall be connected to the phase conductor of the 220kV/132kV/110kV/66kV/25kV system and the other terminal brought out through a 3.6kV class bushing and connected to the tank externally by means of a suitable tin coated copper link. The tank shall be provided with two terminals suitable for taking double earth connection by means of 50mm x 6mm MS flat.
Both the end of secondary winding shall be brought out and terminated on suitable insulated terminals which shall be fully protected by a weather-proof terminal box designed to accommodate cartridge fuses as mentioned in clause 7.6 below and fitted with cable gland suitable for 2.5 sq. mm PVC insulated and PVC sheathed 1.1kV grade conforming to IS:1554 Copper cable.
- 7.3** The connection between primary terminal and primary winding shall be by means of flexible copper wire and shall be provided with crimped copper lugs, nuts and bolts for proper fixing. For better mechanical strength and reliability, it is preferable that primary winding lead connections with the terminal plate are provided at two/three places as shown in the sketch at **Annexure-5**.
- 7.4** The potential transformer shall be of sealed construction with inert gas (Nitrogen) above the insulating oil, and adequately protected against any leakage of gas or oil. A pressure relief device capable of releasing abnormal internal pressure shall however, be provided. The number of gasketed joints shall be restricted to the minimum.
- 7.5** Class 'A' insulation immersed in oil shall be used. The transformer shall be supplied complete with insulating oil conforming to IS:335 and ready for commissioning. The characteristic of insulating oil before energizing the potential transformer shall conform to the parameters of stipulated in IS:1866.
- 7.6** Cartridge type fuse links conforming to ~~BS:9224 (Part II) 1993~~ shall be provided in the weather-proof terminal box for secondary circuit with continuous current rating of 4A except for 25 kV PT (Type-I) of 2A.
- 7.7** The tank shall be of welded mild steel construction designed to withstand internal stresses due to short circuits. All cover seats, flanged joints, threaded connections and pipe fittings shall be properly machined, fitted and gasket to ensure oil tightness. The construction of the tank shall be such as to shed of any rain water.
- 7.8** A port shall be provided on the oil expansion chamber to serve the purpose of oil filling and also for fixing the nitrogen gas filling assembly. The nitrogen gas filling assembly shall be screwed into the oil filling port and shall have its own leak proof sealing. A screwed cap shall be provided on the oil filling port with gasket or 'O' ring provided at suitable location. The internal and external threads

provided on the oil filling port shall be an adequate length and shall conform to the “precision grade” a defined in IS:1367.

7.9 The oil draining pipe provided on the bottom tank shall have suitable internal thread over an adequate length and a threaded plug should be screwed into this pipe. The assembly of the threaded pipe and plug shall conform to the “precision grade” a defined in IS:1367. In addition, a gasket or ‘O’ ring shall be provided at suitable location in the assembly.

7.10 All the bolted mechanical electrical connections in the transformer shall be positively prevented from loosening in the service due to vibration. Standard locking arrangement shall be employed for this purpose.

7.11 The electrical joints (if any) within the transformer winding shall be minimum, and shall be brazed.

7.12 The transformer assembly shall be dried under vacuum till appropriate values of insulation resistance have been obtained. It shall then be impregnated under vacuum with transformer oil conforming to IS:335.

7.13 No grading ring shall be used in the construction of the 25kV PT.

8.0 PORCELAIN HOUSING AND TERMINAL CONNECTORS

8.1 The porcelain housing shall be of single piece construction i.e. there shall be no joint in the porcelain body. The shed profile shall have a lip at the extremities but free from ribs on the underside.

8.2 The design and construction of the porcelain housing shall be such that stresses due to expansion and contraction in any part there of shall not lead to its deterioration/breakage.

8.3 The porcelain housing shall conform to ~~IS:5621-1988~~ **62155 : 2003** and shall withstand the following test voltage:-

i.	Highest system voltage for equipment, kv (rms)	:	245	145	123	72.5	72.5	52
ii.	Rated short duration Wet/dry power frequency withstand voltage kV (rms)	:	460	275	230	140	140	95
iii.	Rated lightning impulse withstand voltage, kV (peak)	:	1050	650	550	325	325	250

8.4 The primary terminal of potential transformer shall preferably be of stainless steel and suitable for vertical take off for fixing a rigid type terminal connector. This terminal plate shall be carefully welded at the location where it passes through the top plate of the expansion chamber shall have adequate mechanical strength and shall be proof against leakage of nitrogen gas and ingress of moisture.

8.5 The terminal connector shall be as per Research Designs and Standard Organization (RDSO), **drawing No.ETI/PSI/P/11120** and shall conform to IS: 5561. The terminal connector drawing is placed at **Annexure-2**. Terminal connectors shall be procured only from approved manufacturers.

~~**8.6** Porcelain housing and terminal connectors—Porcelain housing shall be procured from the following~~

~~approved sources only~~

- ~~(i) M/s Aditya Birla Insulator, Haldol & Rishra~~
- ~~(ii) M/s Insulators & Electricals co. mandideep, Bhopal.~~
- ~~(iii) M/s Modern Insulators Ltd. Abu Road~~
- ~~(iv) M/s WSI, Chennai~~
- ~~(v) M/s JH Porcelain Pvt. Ltd. Khurja (U.P) (for 25 kV only)~~

9.0 FASTENERS

All fasteners of 12mm diameter and less, exposed to atmosphere shall be of stainless steel and those above 12mm diameter shall preferably be of stainless steel or of mild steel hot dip galvanized. The material of the stainless steel fasteners shall conform to IS:1570 - Grade 04, Cr 17 Ni 12 Mo 2.

10.0 PAINTING

- (i.) All steel surfaces in contact with insulating oil shall be properly treated and then painted with heat resistant, oil insoluble insulating varnish.
- (ii.) All steel surfaces exposed to atmosphere shall be properly treated and the painted with one primer coat of zinc chromate and two coats of enamel grade paint to shade 631 of IS:5.
- (iii.) For the Potential transformer to be used over coastal environments, All the external steel surfaces of the Potential transformer exposed to atmosphere including main tank, secondary terminal box & top metallic should be hot dip galvanized for proper protection against corrosive and coastal environments”.

11.0 RATING PLATE

The potential transformer shall be provided with a rating plate (both in Hindi and English) of weather proof material, fitted in a visible position, showing the item indicated below. The lettering/numbering on the plate shall be indelibly marked etching/engraving.

- (i.) Type designation of potential transformer.
- (ii.) Governing specification
- (iii.) Manufacturer's name and country origin.
- (iv.) Manufacturer's serial number.
- (v.) Year of manufacture.
- (vi.) Rated voltage factor and corresponding rated time
- (vii.) Rated frequency
- (viii.) Highest voltage for equipment
- (ix.) Rated voltage
 - (a) Primary
 - (b) Secondary
- (x) Rated output and corresponding accuracy class
- (xi) Maximum temperature rise over an ambient of 50 Deg.C.
 - (a) of oil
 - (b) of winding
- (xii) Rated insulation level
- (xiii) Total weight
- (xiv) Connection diagram

12.0 PARTS FITTINGS AND ACCESSORIES

The following accessories shall be provided with each potential transformer:

- (i.) Rating and diagram plate
- (ii.) Terminal marking plate
- (iii.) Weather proof terminal box
- (iv.) Lifting lugs
- (v.) Cable gland to take cable 2.5mm² / 1100 V grade PVC insulated/PVC sheathed (Heavy Duty) Copper cables.
- (vi.) Oil filling port and nitrogen gas filling valve
- (vii.) Oil drain pipe with plug
- (viii.) Two equipment earthing terminals
- (ix.) Pressure relief device
- (x.) Terminal connector
- (xi.) Oil level site gauge (tough acrylic plastic)
- (xii.) Plain rollers
- (xiii.) Adjustable arcing horn

13.0 DRAWINGS

13.1 The successful tenderer shall submit the following detailed dimensioned drawings along with three prints of each as per Railway Standards in sizes of 210mm x 297 mm or any integral multiple thereof for security/approval. A format of the title sheet to be adopted for preparation of these drawings is attached at **Annexure-3**.

- (i.) Outline general arrangement showing overall dimensions of the PT, position of terminals and base mounting channels.
- (ii.) Cross sectional view showing core, winding, expansion chamber and connection of primary side terminal to primary winding.
- (iii.) Detailed drawing of porcelain housing indicating shed profile, creepage distance and salient electrical and mechanical technical parameter.
- (iv.) Clamping arrangement for porcelain housing.
- (v.) Details of pressure relief device
- (vi.) Details of oil filling port and Nitrogen gas filling valve
- (vii.) Details of secondary terminal assembly
- (viii.) Details of secondary terminal box
- (ix.) Details of Primary terminal plate
- (x.) Details of oil drain plug arrangement
- (xi.) Details of cable gland, 'O' ring and gaskets used.
- (xii.) Details of oil level indicator
- (xiii.) Rating and diagram plate (English and Hindi version)
- (xiv.) Insulation details for active part
- (xv.) Arrangement of earthing terminal.

13.2 The provisionally approved drawings shall be modified, if need be, as a result of changes necessitated during type testing or as desired by the purchaser. The modification shall be first got approved from the Purchaser/~~Director General (Traction Installation), Research Designs and~~

~~Standards Organisation, (DG (TI)RDSO), Lucknow~~ Vendor approving authority and then incorporated in the drawing and each such modifications shall be got signed by the authority concerned on the drawing. If there are no modifications at all, the provisionally approved drawing shall be finally approved.

13.3 Six copies of approved drawings along with two sets of reproducible shall be sent to each consignee(s), as indicated in the purchase order .Besides two copies of drawings along with one set of reproducible tracings ,drawings ~~on the floppy (Auto CAD R-14)~~ in soft copy after final approval of the drawings shall be supplied to CEO/CORE/ALD and one set of drawing to DG/TI/RDSO Lucknow.

13.4 The successful tenderer shall also be required to supply atleast two copies of the “Inspection and Maintenance Manual” for potential transformer to each consignee CEo/CORE/ALD and one copy to DG(TI)RDSO, Lucknow-226011.

14.0 TESTING OF TRANSFORMER

14.1.1 Once a purchase order is placed for supply of a potential transformer (PT) the design and drawings shall be furnished to the Purchaser/~~DG (TI), RDSO, Lucknow~~ Vendor approving authority as the case may be within the period stipulated in the purchase order. Only after all the design and drawings as well as quality assurance plan (QAP) have been approved for prototype tests and written advice given to that effect, successful tenderer manufacturer shall take up manufacture of the prototype of the potential transformer. It is to be clearly understood that any change or modification required by the above authorities to be done in the prototype shall be done expeditiously, not withstanding approval having already been given for the designs and drawings. Such change of modification shall be incorporated in the drawing as indicated in clause 13.0.

14.1.2 Prior a giving a call to the purchaser/~~DG(TI), RDSO, Lucknow~~ Vendor approving authority, for inspection and testing of the prototype, the successful tenderer / manufacturer shall submit a detailed test schedule containing procedures and schematic circuit diagrams for each of the tests and the number of days required to complete all the tests at once stretch. Once the scheduled is approved, the tests shall invariably be done accordingly. However, during the process of type testing or even later, the purchaser reserves the right to conduct any additional test(s), besides those specified herein, on any equipment/item so as to test the equipment/item to his satisfaction or for gaining additional information and knowledge.

In case any dispute or disagreement arises between the successful tenderer/manufacturer and representative of the Purchase/~~DG(TI), RDSO, Lucknow~~ Vendor approving authority, during the process of testing as regards the procedure for the type tests and or the interpretation and acceptability of the result of type tests, it shall be brought to the notice of the Purchaser/~~DG(TI), RDSO, Lucknow~~ Vendor approving authority, as the case may be, whose decision shall be final and binding.

Only after the prototype transformer is completed and ready in each and every respect, shall the successful tenderer/manufacturer give the actual call for the inspection and testing with at least 15 days notice for the purpose.

14.1.3 In the event of the test not being completed at once stretch for any reason attributable to the successful tenderer/manufacturer & it is required for the representative of the Purchaser/~~Director General (Traction Installation), Research Designs and Standards Organisation, (DG (TI)RDSO), Lucknow~~ **Vendor approving authority**, to go again or more number of times to the works of the successful tenderer/manufacturer or other place(s) for continuing &/or completing the tests on the prototype(s) of the equipment, the successful tenderer/manufacturer shall reimburse to the Purchaser/~~(DG (TI)RDSO), Lucknow~~ **Vendor approving authority**, the costs for the representative having to visit to the works or other place (s) for the tests more than once. The cost as claimed by the Purchaser/ ~~(DG (TI)RDSO), Lucknow~~ **Vendor approving authority**, shall be paid through a demand draft to the concerned accounts officer of the Purchaser/ ~~(DG (TI)RDSO), Lucknow~~ **Vendor approving authority** as shall be advised to the successful tenderer/manufacturer. However this shall be reviewed by Purchaser/ ~~(DG (TI)RDSO), Lucknow~~ **Vendor approving authority**, based upon the factual conditions/circumstances at the time of conducting tests.

14.1.4 The type test shall be carried out on the prototype transformer at the works of the successful tenderer/manufacturer or at a reputed testing laboratory in the presence of the representative of the Purchaser/ ~~(DG (TI)RDSO), Lucknow~~ **Vendor approving authority**, in accordance with the relevant specifications and as modified or amplified by this specification.

14.2 TYPE TEST

14.2.1 The type test shall be carried out on the prototype PT at the works of the successful tenderer/manufacturer or at a reputed testing laboratory in the presence of the representative of the purchaser/~~DG(TI), RDSO, Lucknow~~ **Vendor approving authority**, and in accordance with the relevant specifications and as altered, amended or supplemented by this specification.

- (i.) Temperature rise test
- (ii.) Lightning impulse test
- (iii.) Chopped lightning impulse test
- (iv.) High voltage wet power frequency withstand
- (v.) Determination of errors
- (vi.) Short circuit withstand capability test

14.2.1.1 TEMPERATURE RISE TEST

The test shall be done in accordance with clause ~~9.5 of IS:3156 (Part I) 1992~~ **7.2.2 of IS:16227-Part3-2015**. The maximum temperature rise of the PT after continuous operation shall not exceed the following values over an ambient temperature of 50°C.

- (i.) For windings 45°C, (by resistance method)
- (ii.) For insulating oil 35°C (by thermometer)

14.2.1.2 LIGHTNING IMPULSE TEST

The test shall be done in accordance with clause ~~9.6 of IS:3156 (Part I) 1992~~ **7.2.3 of IS:16227-Part3-2015**. The PTs after withstand an impulse test voltage of:

- (i.) Highest voltage for equipment, : 245 145 123 72.5 52

kV (rms)					
(ii.) Lightning impulse withstand voltage, kV (peak)	:	950	650	550	325 250

14.2.1.3 CHOPPED LIGHTNING IMPULSE TEST

The test shall be carried out on primary winding in accordance with clause ~~9.7 of IS:3156(Part I) 1992~~ **7.4.1 of IS:16227-Part3-2015** and the test voltage are same as under clause 14.2.1.2.

14.2.1.4 HIGH VOLTAGE WET POWER FREQUENCY WITHSTAND TEST

The test shall be conducted in accordance with clause ~~9.7 of IS:3156(Part I) 1992~~ **7.2.4 of IS:16227-Part3-2015**. The test voltage shall be applied as under:

(i.) Highest voltage for equipment, kV (rms)	:	245	145	123	72.5	52
(ii.) Rated power frequency withstand voltage (wet) , kV (peak)	:	395	275	230	140	95

14.2.1.5 DETERMINATION OF ERRORS

Determination of errors shall be carried out in accordance with ~~IS:3156 (Part II) 1992 & IS:3156 (Part III) 1992~~ **5.6 of IS:16227-Part3-2015** in conformity with clause 6.2 of this specification.

14.2.1.6 SHORT CIRCUIT WITHSTAND CAPABILITY TEST

This test shall be conducted in accordance with clause ~~9.9 of IS:3156 (Part I) 1992~~ **7.2.301 of IS:16227-Part3-2015** .

14.3 TYPE TEST ON ACCESSORIES

14.3.1 PORCELAIN HOUSING

The porcelain housing shall be tested in accordance with ~~IS:5621-1988~~ **62155 : 2003** and shall also meet the requirements of clause 8.0 of this specification.

14.3.2 TERMINAL CONNECTORS

The terminal connectors shall be tested in accordance with IS:5561.

14.3.3 PRESSURE RELIEF DEVICE

The pressure relief device shall be subjected to air pressure test and leakage test. The pressure relief device should operate at a pressure between 2.5 to 4.5 kg./cm².

14.3.4 INSULATING OIL

The sample of insulating oil drawn from the prototype unit shall be tested in accordance with IS:335.

14.4 ROUTINE TEST

- 14.4.1** The following routine tests shall be performed on each PT including prototype in accordance with IS:335-1992.
- (i.) Visual examination
 - (ii.) Verification of polarity of terminal markings
 - (iii.) Measurement of winding resistance
 - (iv.) Measurement of insulation resistance
 - (v.) Power frequency dry withstand test on primary winding
 - (vi.) Power frequency dry withstand test on secondary winding
 - (vii.) Determination of errors
 - (viii.) Partial discharge measurement (Applicable for nominal system voltage above 66kV).

14.4.1.1 VISUAL EXAMINATION

A great examination shall be made to check that the potential transformer conforms to the approved drawing, various items are accessible for maintenance, the quality of workmanship and finish are of acceptable standards and all parts, accessories are provided.

14.4.1.2 VERIFICATION OF TERMINAL MARKING AND POLARITY

Terminal markings and polarity shall be verified as per clause 9.2 of IS:3156 (Part I) 1992 6.13 of IS:16227-Part3-2015 .

14.4.1.3 MEASUREMENT OF WINDING RESISTANCE

The resistance of primary and secondary windings shall be measured and computed to 75°.

14.4.1.4 MEASUREMENT OF INSULATION RESISTANCE

The insulation resistance between primary and secondary windings and between secondary winding and earth shall be measured with 500 megger.

14.4.1.5 POWER FREQUENCY DRY WITHSTAND TEST ON PRIMARY WINDING

This test shall be conducted in accordance with clause 9.3 of IS:3156 (Part I) 1992 7.3.1 of IS:16227-Part3-2015. The test voltage shall be applied as under:

- | | | | | | | | |
|-------|---|---|-----|-----|-----|------|----|
| (i.) | Highest voltage for equipment, kV (rms) | : | 245 | 145 | 123 | 72.5 | 52 |
| (ii.) | Rated short duration power frequency withstand voltage, kV (peak) | : | 395 | 275 | 230 | 140 | 95 |

The induced over voltage withstand test shall be done in accordance with clause 9.3.2.2 of IS:3156 (Part I) 1992 7.3.1 of IS:16227-Part3-2015. As one end of the primary winding is solidly earthed in these PTs, separate source withstand voltage test can't be conducted.

14.4.1.6 POWER FREQUENCY DRY WITHSTAND TEST ON SECONDARY WINDING

This test shall be conducted in accordance with clause 9.4 of IS:3156 (Part I) 1992 7.3.4 of IS:16227-Part3-2015. The test voltage applied shall be 3kV rms for one minute between

secondary winding terminals & earth.

14.4.1.7 DETERMINATION OF ERRORS (ACCURACY CLASS)

This test shall be conducted in accordance with ~~IS:11322-1990~~ IS : 4146.

14.5 In the event of the potential transformer failing in any one of the tests, further tests will not be carried out by the representative of the purchaser/DG/TI/RDSO. The manufacturer, after carrying out the necessary rectification/modifications as required on the potential transformer with the further approval from the purchaser/ DG(TI)RDSO, offer a fresh prototype for carrying out all the tests stipulated above.

15.0 TECHNICAL DATA AND DRAWINGS

15.1 The tender shall finish along with his offer, in the proforma at Annexure -4, the schedule of Guaranteed Performance and Other Particulars (SOGP) for the potential transformer. The particulars shall be corrected and complete in all respects. If there is any entry like “shall be furnished later” or a blank against any item, the offer is not likely to be considered as the evaluation of the offer is rendered different and cannot be compared with other offers, if any.

15.2 The tender shall specifically indicate in a “Statement of Compliance” attached with the offer, his compliance with each and every clause of this specification. In case the tenderer wishes to deviate from any clause of this specification he may do so giving reference to the clause (s) with the reasons/justification for the deviation. This shall be in the form of a separate statement called the “Statement of Deviation”. If there is no deviation at all, a specific “NIL”, “Statement of Deviation” shall be attached with the offer. If the “Statement of Compliance” and “Statement of deviation” are not attached with the offer, it is not likely to be considered for the reason that it is an incomplete offer which cannot be properly evaluated and compared with other offers, if any.

15.3 The tendered shall furnish the following drawings, along with the offer:

- (i.) Outline general arrangement drawing giving the overall dimensions of the potential transformer along with a cross sectional view.
- (ii.) Rating and diagram plate.
- (iii.) Internal arrangement of the PT including cross sectional views

15.0 SPARES

Wherever required, the tendered shall quote apart from main equipment, separately for recommended spares required for five years operations.

The tenderer shall also quote separately for the following essential spares.

- (i) Primary porcelain housing.
- (ii) Primary terminal connector.

17.0 TRANSPORTATION OF THE POTENTIAL, TRANSFORMER

17.1 The potential transformer may be transported according to the transport facilities available for the route, viz by rail, road or sea. All parts, fittings and accessories which are liable to damage during transit shall be removed and packed /crated separately; detached parts may be packed, crated and sent with potential transformer along with the check list, so that all

the parts are available at the destination with the unit. The packing has to be done properly so that no damage occurs during transit.

- 17.2** The various components of each potential transformer shall be securely package in wooden crates/boxes. General packing list, together with weight and overall dimensions of packing cases shall be furnished for each transformer indicating the following particulars:

Crate No.	Description of item/component in the crate	Approx. gross Weight in kg.	Approx. outside Dimensions
-----------	--	-----------------------------	----------------------------

- 17.3** As far as possible, the gross weight of the crate/box shall be so kept that it can be conveniently handled by two persons.

- 17.4** In case pf overseas supplies, packing shall be sea worthy.

- 17.5** Necessary instruction for handling and storage of all items shall be included alongwith the packing lists

18.0 AFTER SALE SERVICES

- ~~**18.1** The successful tenderer shall make necessary arrangements for closely monitoring the performance of the transformer (s) through periodical (preferably once in two months during the warranty period) visits to the locations where they have been erected for observation and interaction with the operating and maintenance personnel of the Indian Railways. Arrangements shall also be made by the successful tenderer/manufacturer for emergency/stand by spare parts and complete units being kept readily available to meet emergencies warranting replacement so as to keep transformers in service with least down time.~~

- ~~**18.2** The successful tenderer shall respond promptly and in workmen like manner to any call given by Indian Railways for any assistance by way of attending to failures, investigation into the causes of failures including tests, if any, to be done and such other items with a view to see that the transformer serves the purpose for which it is intended. Besides technical guidance to ensure proper operation and maintenance of the transformer shall be constantly rendered.~~

~~**19.0 WARRANTY**~~

- ~~**19.1** The successful tenderer/manufacturer shall warrant that all equipment shall be free from defects and faults in design, material, workmanship and manufacture and shall be of the highest grade consistent with the established and generally accepted standards for the equipment of the type ordered and in full conformity with the specifications and shall operate properly.~~

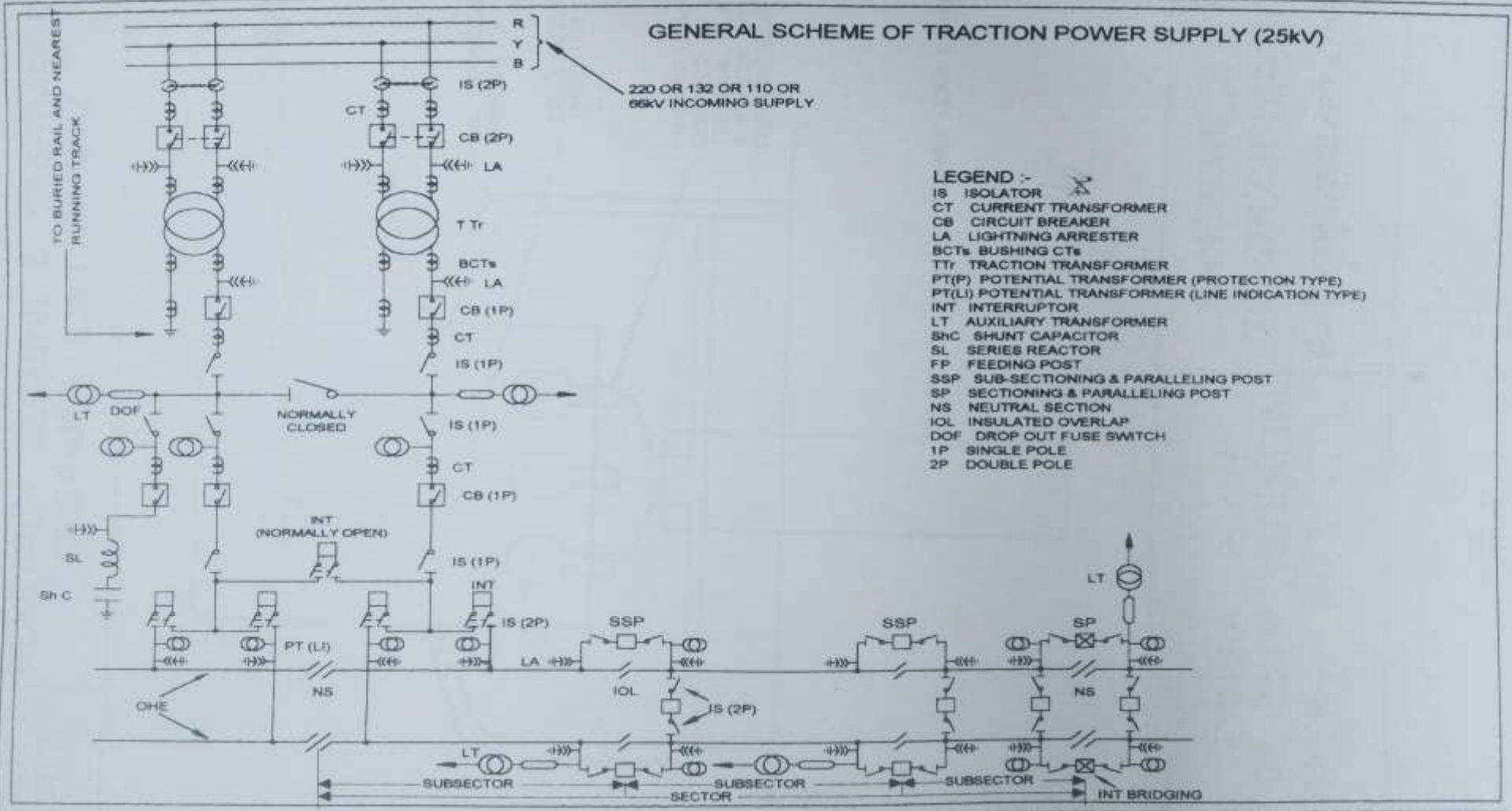
- ~~**19.2** This warranty shall survive inspection of, payment for and acceptance of the equipment, but shall expire 24 (Twenty Four) months after the delivery at ultimate destination in India, or 18 (Eighteen) months from the date of commissioning and proving test of the equipment at ultimate destination in India, whichever period expires earlier, except in respect of complaints, defects and/or claims notified to the successful tandrer/manufacturer within 3 (Three) months of the expiry of such date. Any approval or acceptance by the Purchaser of the equipment shall not in any way limit the successful tenderer/manufacturer's liability.~~

- ~~**19.3** The successful tenderer/manufacturer's liability in respect of any complaint, defects and/or claims shall be limited to the furnishing and installation or replacement parts free of any~~

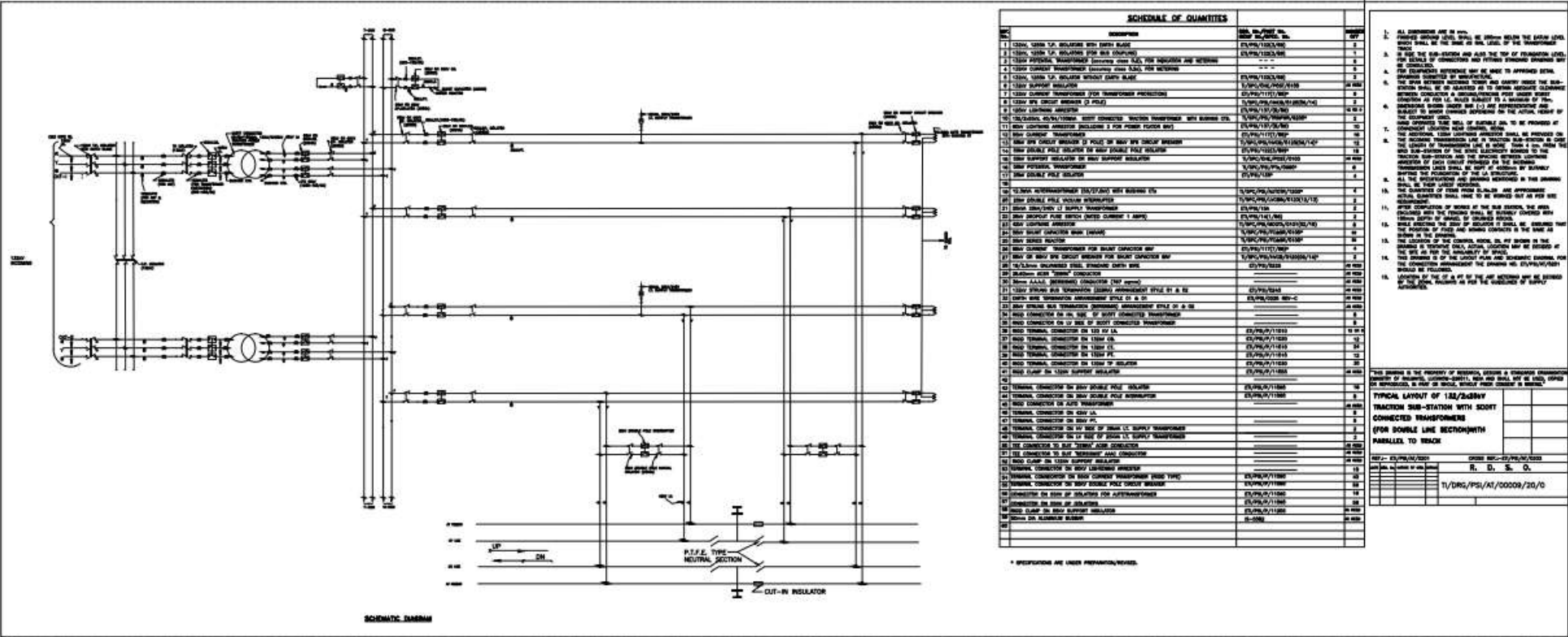
~~charge or the repair of defective parts only to the extent that such replacement or repairs are attributable to or arise from faulty workmanship or material or design in the manufacture of the goods, provided that the defects are brought to the notice of the successful tenderer/manufacturer within 3)Three months of their being first discovered during the warranty period of 3 (Three) months from the date of expiry of warranty period, or at the option of the Purchaser, to the payment of the value, expenditure and damage as hereafter mentioned.~~

- ~~19.4~~ The successful tenderer/manufacturer shall, if required, replace or repair the equipment or such portion thereof is rejected by the Purchaser free of cost at the ultimate destination or at the option of the purchaser, the successful tenderer/manufacturer shall pay to the Purchaser value thereof at the contract price or in the absence of such price at a price decided by the Purchaser and such other expenditure and damages as may arise by reason of the breach of conditions herein specified.
- ~~19.5~~ All replacement and repairs that the Purchaser shall call upon the successful tenderer/manufacturer to deliver under this warranty shall be delivered and performed by the successful tenderer/manufacturer, promptly and satisfactory and in any case within 2(two) months of the date of advice to this effect.
- ~~19.6~~ If the successful tenderer/manufacturer so desires, the parts that are removed may be taken over by him or his representative for disposal as he deems fit at the time of replacement with good parts. No claim whatsoever shall lie on the Purchaser thereafter for the parts so removed.
- ~~19.7~~ The warranty herein contained shall not apply to any material which shall have been repaired or altered by the Purchaser or on his behalf in any way without the consent of the successful tenderer/manufacturer, so as to effect the strength, performance or reliability or to any defects to any part due to misuse, negligence or accident.
- ~~19.8~~ The decision of the Purchaser in regard to successful tenderer/manufacturer's liability and the amount, if any payable under this warranty shall be final and conclusive.

GENERAL SCHEME OF POWER SUPPLY FOR 25 KV AC SYSTEM

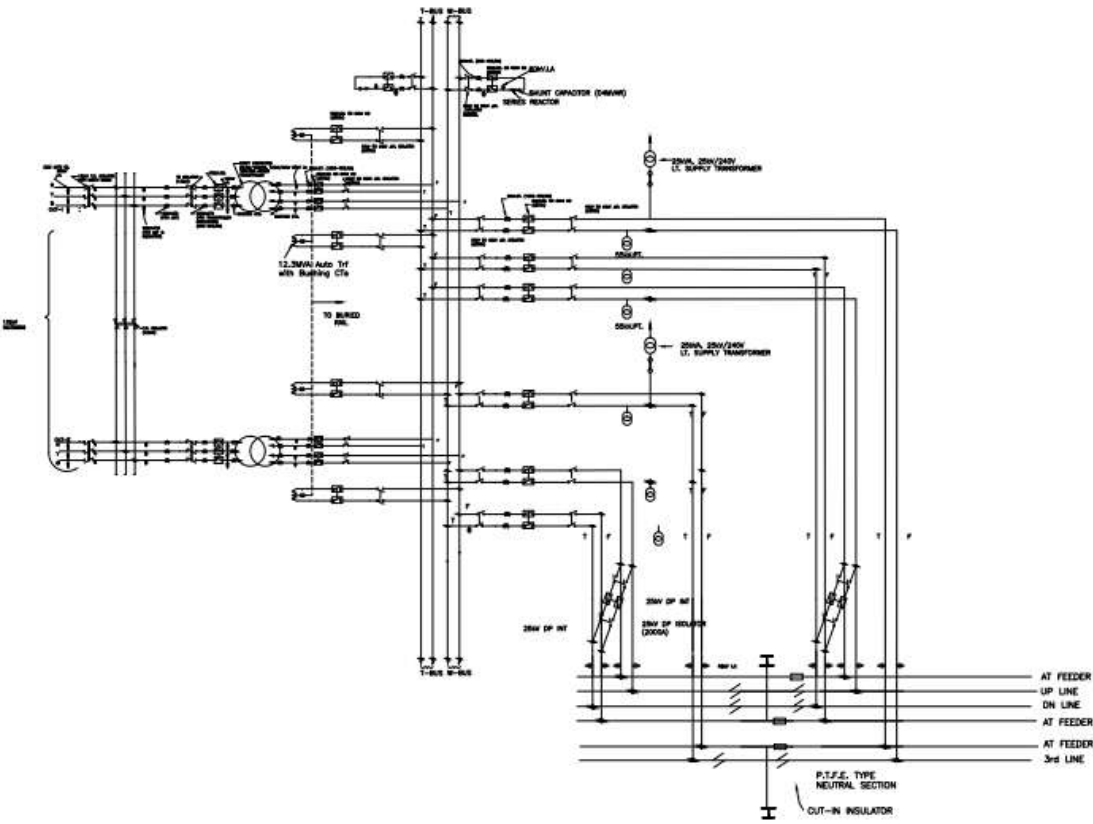


GENERAL SCHEME OF POWER SUPPLY FOR 2 x25 kV AC NEW SYSTEM



132kV Double Line Scott parallel to track

GENERAL SCHEME OF POWER SUPPLY FOR 2 x25 kV AC NEW SYSTEM

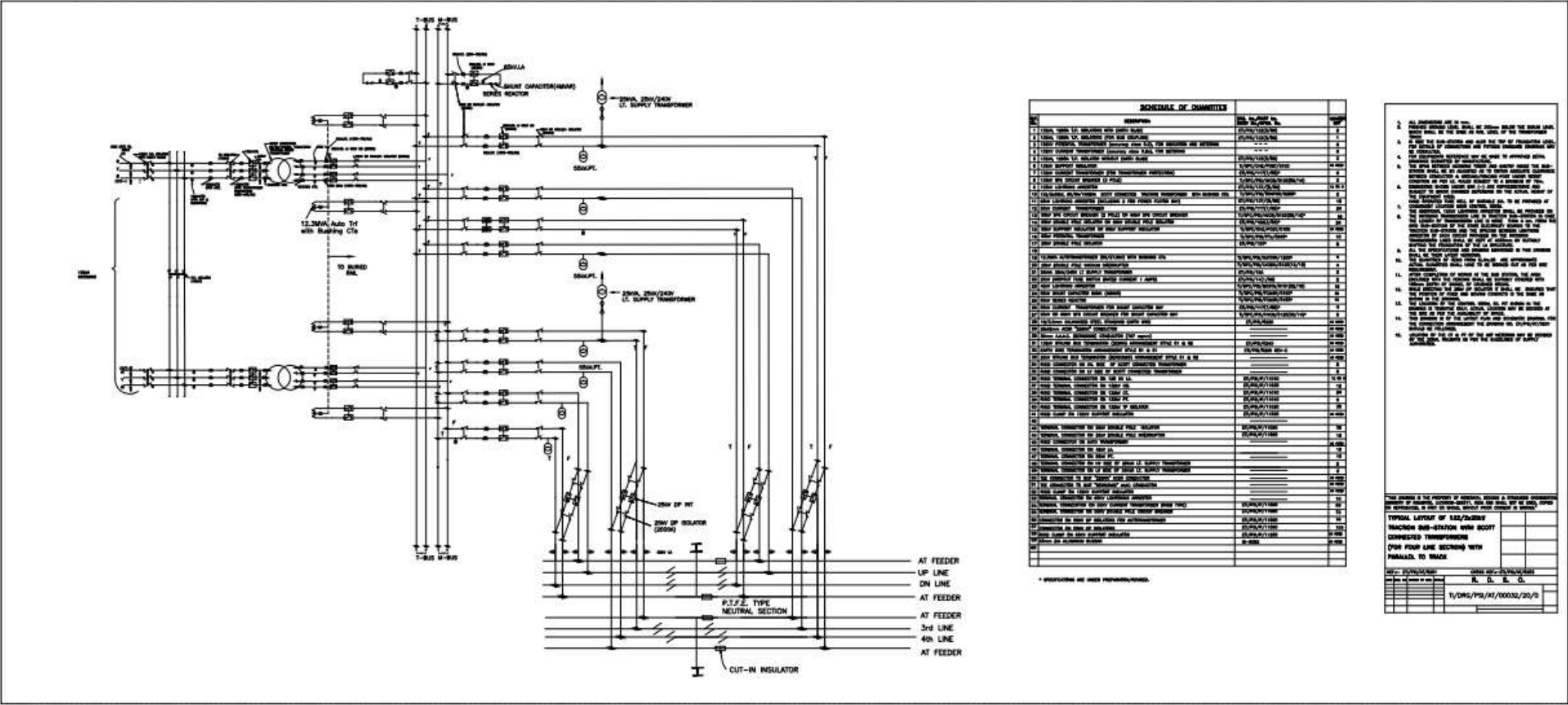


SCHEDULE OF QUANTITIES		
Sl. No.	Description	Qty
1	132KV 3-Phase Bus	3
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3	132KV 3-Phase Bus	3
4	132KV 3-Phase Bus	3
5	132KV 3-Phase Bus	3
6	132KV 3-Phase Bus	3
7	132KV 3-Phase Bus	3
8	132KV 3-Phase Bus	3
9	132KV 3-Phase Bus	3
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44	132KV 3-Phase Bus	3
45	132KV 3-Phase Bus	3
46	132KV 3-Phase Bus	3
47	132KV 3-Phase Bus	3
48	132KV 3-Phase Bus	3
49	132KV 3-Phase Bus	3
50	132KV 3-Phase Bus	3

1. All dimensions are in mm.
2. Unless otherwise specified, all materials shall be of the best quality available in the market.
3. All dimensions shall be in accordance with the Indian Standards.
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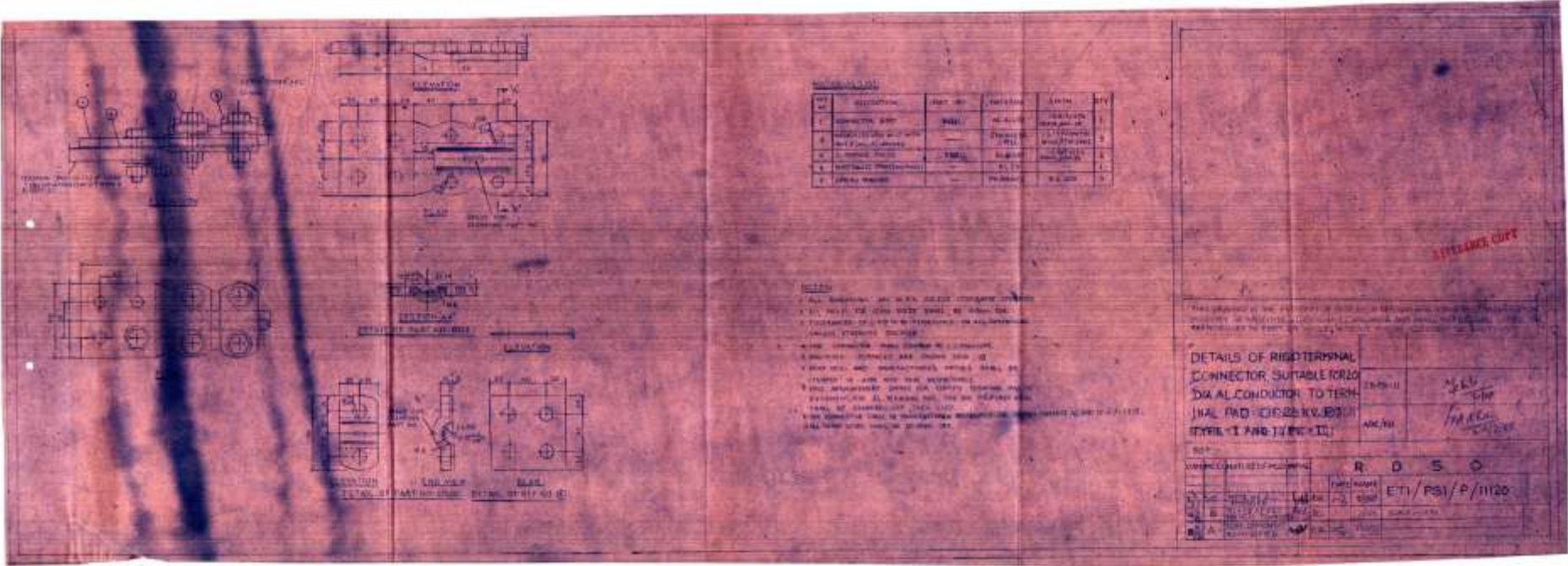
132kV Triple Line Scott parallel to track

GENERAL SCHEME OF POWER SUPPLY FOR 2 x25 kV AC NEW SYSTEM



132kV Four Line Scott parallel to track

ANNEXURE-2



ANNEXURE-3

<p style="writing-mode: vertical-rl; transform: rotate(180deg);">PRINT CUTTING LINE TRACING CUTTING LINE BORDER LINE</p> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> </div> <div style="width: 5%; text-align: center;"> <p>3 3 3 3 3</p> </div> <div style="width: 45%;"> <p>15 15 15</p> </div> </div>	<p>FOLDING MARK</p> <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:70%;">CONTRACTOR'S NAME</td> <td style="width:30%;">GROUP NO.</td> </tr> <tr> <td></td> <td>CONTRACTOR'S DRG. NO.</td> </tr> <tr> <td></td> <td>DATE</td> </tr> </table> <p style="text-align: center;">FORM-3</p> <p>NOTE:- THIS TITLE SHEET IS APPLICABLE TO ALL CONTRACTOR'S DRAWINGS * COL. FOR IDENTIFICATION NO. TO BE FILLED UP ONLY FOR COMPONENT OR FITTING DRAWINGS</p> <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:60%;">TITLE OF DRAWING</td> <td style="width:40%;">APPROVED IN PRINCIPLE</td> </tr> <tr> <td></td> <td>FOR DIRECTOR GENERAL (TI) R.D.S.O.</td> </tr> <tr> <td></td> <td>SIGNATURE OF RESIDENT ENGINEER (CONTRACTOR)</td> </tr> <tr> <td></td> <td>SIGNATURE OF DESIGN ENGINEER (CONTRACTOR)</td> </tr> <tr> <td></td> <td>CROSS REF.</td> </tr> </table> <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th colspan="4">INDIAN RAILWAYS</th> </tr> <tr> <th>DATE</th> <th>MOD.</th> <th>NATURE OF MOD.</th> <th>INITIALS</th> </tr> <tr> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> </tr> </table> <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:60%;">WORKING</td> <td style="width:40%;">INDENT NO. *</td> </tr> <tr> <td></td> <td>SCALE: 1:1</td> </tr> </table>	CONTRACTOR'S NAME	GROUP NO.		CONTRACTOR'S DRG. NO.		DATE	TITLE OF DRAWING	APPROVED IN PRINCIPLE		FOR DIRECTOR GENERAL (TI) R.D.S.O.		SIGNATURE OF RESIDENT ENGINEER (CONTRACTOR)		SIGNATURE OF DESIGN ENGINEER (CONTRACTOR)		CROSS REF.	INDIAN RAILWAYS				DATE	MOD.	NATURE OF MOD.	INITIALS																	WORKING	INDENT NO. *		SCALE: 1:1
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ANNEXURE-4

SCHEDULE OF GAURANTEED PERFORMANCE TECHNICAL AND OTHER PARTICULARS

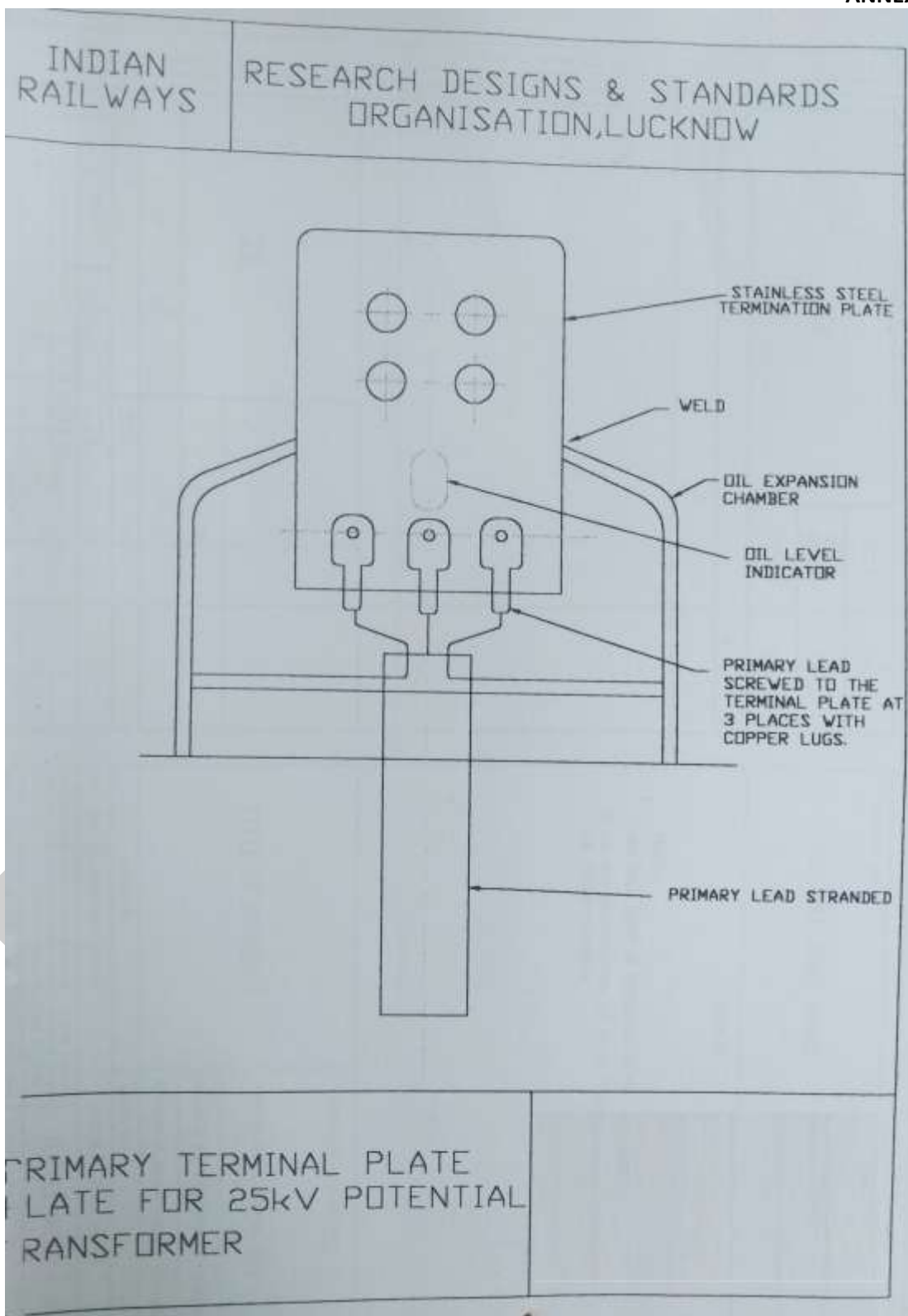
S. No.	Description	Unit of measurement	Value/ information 220kV/132kV/110kV/66kV/25kV (Type I & II)
1.	Name of the manufacturer		
2.	Country of origin		
3.	Standard governing specification		
4.	Manufacturer's type designation.		
5.	Rated (system) voltage. (a) Highest system voltage for equipment (b) Rated primary winding voltage (c) Rated secondary winding voltage	kV rms kV rms kV rms	
6.	Rated frequency	Hz	
7.	Insulation resistance between secondary winding & earth and between primary & secondary winding	Mohm	
8.	Rated burden	VA	
9.	Rated voltages and transformation ratio		
10.	Class of accuracy Ratio error(%) and phase angle error (minute) (a) For voltage varying from 90% to 110% or 80% to 120% of rated voltage. (b) For voltage varying from 0.5% to 120% of rated voltage.		
11.	Rated voltage factor		
12.	Maximum temperature rise after continuous full load operation of: (a) Oil by thermometer. (b) winding by resistance	°C °C	
13.	Winding particulars: (a) Type of primary winding (b) Current density in primary winding (c) Size and no. of turns of conductors for primary/ secondary winding. (d) Class of insulation (e) Rated insulation levels: (i) Impulse withstand voltage (ii) Power frequency induced withstand voltage. (f) Resistance of primary winding at 75°C (g) Resistance of secondary winding at 75°C	A/mm ² kV peak kV rms Ohms Ohms	
14.	Core particulars: (a) Type of core (b) Flux density at rated voltage and frequency. (c) Thickness of steel laminations	Tesla mm.	

	(d) Whether CRGO steel stampings used?	yes/no	
15.	Porcelain housing/bushing particulars. (a) Name of the manufacturer (b) Standard Governing Specification. (c) One minute dry power frequency with stand. (d) One minute wet power frequency with stand. (e) Lightning Impulse withstand (f) Under oil flashover or puncture withstand, Power frequency voltage. (g) Under oil flashover or puncture with stand, Impulse voltage. (h) Creepage distance in air. (i) Weight of bushing/ porcelain housing.	kV rms kV rms kV peak kV rms kV peak mm kg.	
16	LT Fuse Particulars: (a) Make & Type (cartridge or rewirable) (b) Continuous current rating (c) Fusing current (d) Governing Specification	 A A	
17.	Weights and dimension (a) Net weight of core (b) Net weight of copper (c) Net weight of primary winding (d) Net weight of secondary winding (e) Quality of insulating oil (volume) (f) Weight of insulating oil (g) Total weight of potential transformer with oil (h) Overall dimensions of the assembled Transformer Height (topmost) Length Breadth	kg kg kg kg l Kg kg mm mm mm	
18.	Whether the PT is of sealed construction with insert gas at top?		Yes/no
19.	Whether terminal connectors will be provided.		Yes/no
20.	Are the exposed fasteners of 12mm dia or less of, stainless steel?		Yes/no
21.	Are the fasteners of more than 12mm dia exposed to atmosphere are of stainless steel or of MS hot dip galvanized?		-----
22.	Is the porcelain housing of single piece construction		Yes/no
23.	Is the shed profile of porcelain housing free from under ribs, but has a lip?		
24.	Pressure relief devices are provided or not?		Yes/no

25.	Whether deviation statement submitted?		Yes/no
26.	Is the warranty as per clause 19.0?		Yes/no
27.	Is the list of spares furnished?		Yes/no
28.	Are all the drawings required as per clause 15.3 attached?		Yes/no

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ANNEXURE-5



ANNEXURE-6

LIST OF ABBREVIATIONS

ABBREVIATIONS	FULL FORM OF THE ABBREVIATION
OHE	Over head equipment
PT	Potential transformer
TSS	Traction sub-station
SP	Sectioning and Paralleling Post (Switching Station)
QAP	Quality Assurance Plan
DG (TI)	Director General (Traction Installation)

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ANNEXURE-7

1. SCOPE

This part of specification cover design, manufacture, testing, inspection, packing and supply, of 110 kV potential transformers to the specification given below to be used in Mumbai area at traction sub-station with 30MVA transformers and required to be operated in parallel with adjacent traction sub-stations.

2.0 RATING AND OTHER PARTICULARS

1.	Type	Single phase oil filled natural air cooled Outdoor
2.	Nominal system voltage,kV	110 kV
3.	Highest operating voltage	123 KV
4.	Rated Frequency	50 Hz +/-3%
5.	Neutral earthing	Effectively grounded
6.	Maximum temperature rise of windings immersed in oil	45° C over an ambient of 50° C
7.	One minute 50 Hz withstand voltage/induced over voltage	230 kV (rms)
8.	Impulse withstand voltage, positive and negative polarity 1.2/50 microsecond wave	550 KV
9.	Minimum creepage distance of insulator (31mm/kV), mm	3813
10.	P.T. Ratio 1) Rated primary voltage, kV (rms) 2) Rated secondary voltage, V	100-110/√3 kV 110/√3 V-110/√3 V
11.	Application	Metering on winding 1, Protection on winding 2.
12.	Rated Burden	100 (Winding -1) 200 (Winding -2)
13.	Rated P.F.	0.8
14.	Accuracy Class	0.2 for winding 1 and 3P for winding 2
15.	Rated voltage factor	1.2 continuous & 1.5 for 30 sec.
16.	The ratios corresponding to	$\frac{110\text{kV}/110\text{ V}-110\text{ V}}{\sqrt{3} \quad \sqrt{3} \quad \sqrt{3}} \quad \text{and}$ $\frac{100\text{kV}/110\text{ V} - 110\text{V}}{\sqrt{3} \quad \sqrt{3} \quad \sqrt{3}}$ Should be achieved by providing tap on the secondary windings.
17.	The neutral terminal for the HT winding should be brought out through a bushing rated for 3 Kv.	

3.0 CONSTRUCTION

The Potential transformers shall be hermetically sealed. They shall be suitable for upright mounting on steel structures. They shall be provided with nitrogen cushions.

4.0 GENERAL

4.1 The Potential transformers shall be designed to withstand forces corresponding to a seismic acceleration 0.1 g.

4.2 Potential transformers shall be provided with unthreaded stud/flat terminus made of tinned copper at top for connections to consumer's 110 kV bus bars of IPS pipes.

4.3 The PT secondary shall be provided with disconnecting type links and necessary fuses either in the secondary terminal box or in a separate junction box.

4.4 Design and construction of Potential transformers shall be sufficient to withstand the thermal

and mechanical stresses that they may be subjected to while in service. The Core lamination shall be of high grade steel or other equivalent alloy. The exciting current shall be as low as possible and the Potential transformer shall be capable of maintaining its rated accuracy for burdens and saturation limits specified in Part one.

- 4.5 The Secondary terminals shall be brought out in a weather-proof terminal box. The terminal box shall be provided with glands suitable for 2;Nos. 1100 V grade, steel wire armoured, PVC sheathed multicore, 2.5/4 sq.mm cables.
- 4.6 Polarity marks shall be indelibly marked on the primary terminals of the Potential transformer and on the secondary lead terminations at the associated terminal block. For PT the secondary fuses shall be incorporated in the secondary terminal box.
- 4.7 Potential transformer shall be provided with nameplate showing particulars and diagram of the connections. They shall be made of non-corrosive material, shall be indelibly marked and firmly fixed on to the body of Potential transformer.
- 4.8 The potential transformers shall be supplied complete with insulating oil conforming to IS: 12463 and railway requirements. The insulating oil shall be procured from the manufacturers approved by RDSO. The successful tenderer/manufacture shall submit test certificates as per IS: 12463 for oil.
- 4.9 All ferrous parts exposed to atmosphere including main tank, secondary terminal box & top metallic should be hot dip galvanized.
- 4.10 Equipment covered under this specification shall withstand seismic acceleration force corresponding to 0.1 g.
- 4.11 The tenderer shall furnish their compliance or otherwise against each clause/subclause of the technical specification. If the tenderer wishes to deviate from the provision of any clause/sub-clause, he shall furnish the full details with justification for such deviation.
- 4.12 Detailed drawings of PT along with SOGP shall be furnished for RDSO's approval before manufacture is taken up.

5.0 TESTS

The following Type & Routine tests as per RDSO specification no. TI/SPC/PSI/PTs/0990 with A&C slip no. 1 & 2, IS: 3156 and relevant IEC shall be conducted on the potential transformer required for Mumbai area under DC-AC conversion

5.1 Type tests

- 5.1.1 Temperature rise test
- 5.1.2 Lightning impulse test
- 5.1.3 Chopped Lightning impulse test
- 5.1.4 High voltage wet power frequency withstand test
- 5.1.5 Determination of errors
- 5.1.6 Short circuit withstand capability test
- 5.1.7 Determination of capacitance dissipation factor.

5.2 Routine tests

- 5.2.1 Visual examination
- 5.2.2 Verification of polarity and terminal markings
- 5.2.3 Measurement of winding resistance
- 5.2.4 Measurement of insulation resistance
- 5.2.5 Power frequency dry withstand test on primary winding
- 5.2.6 Power frequency dry with stand test on secondary winding
- 5.2.7 Determination of errors
- 5.2.8 Partial discharge measurement
- 5.2.9 Oil leakage test.

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