



SUPPLY CHAIN MANAGEMENT

THIRUVANANTHAPURAM

SPECIFICATION

220KV & 110KV INDUCTIVE VOLTAGE TRANSFORMERS (POTENTIAL TRANSFORMERS)

APPLICABLE TO KSEBL	Rev#1	DOC. NO.: SCM-SPEC/XT/220kV & 110kV IVT (PT)
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(i) Document Approval & Control Status: (R0)

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(ii) Amendments and History

Sec. #	Rev. #	Date	History of Change
2, 8, 13, 14, 15	R1	12/07/2022	IS / IEC Standard corrected
3	R1	12/07/2022	110kV PT core corrected from 2 to 3. Ratio, burden, accuracy class modified for 110kV PT
6.2	R1	12/07/2022	Secondary voltage corrected
6.3	R1	12/07/2022	Secondary TB Added
7 (1)	R1	12/07/2022	Simultaneous Burden added
12	R1	12/07/2022	Foundation bolts added
15	R1	12/07/2022	“or two” deleted
15, 16	R1	12/07/2022	List of Tests modified in line with IS: 16227 / IEC: 61869



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1. PURPOSE:

Purpose of this document is to document updates & history, upkeep and publish the specifications related to **220kV & 110kV Inductive Voltage Transformers (Potential Transformers)** in a professional manner

2. SCOPE:

The Scope of this document is to inform and alert all relevant stakeholders including KSEBL, Public, KSERC etc regarding the current specifications and historical changes adopted in specifications of **220kV & 110kV Inductive Voltage Transformers (Potential Transformers)** used in field by KSEBL

3. RESPONSIBILITY:

The Executive Engineer (T), Office of Chief Engineer, Supply Chain Management shall compile and take necessary steps to publish the specification in KSEBL website and shall inform relevant stakeholders regarding updates and revisions

4. PROCEDURE FOR REVISION:

Modifications if any, in the technical specification will be incorporated as **Revisions**. Any changes in values, minor corrections in pages, incorporation of small details etc. will be considered as Minor Modification. **The Revisions due to minor modifications will be assigned as Rev. No.0.1, 0.2 etc.**

A complete updation of the technical specification will be considered as Major modification. **The Revisions due to major modifications will be assigned as Rev. No.1.0, 2.0 etc.**

All the details of regarding the revisions (both minor and major) will be incorporated in **“(ii)-Amendments and history”** above.

The concerned officers, in consultation with the Technical Committee will review and suggest changes required and the revision suggestion will be approved by **Chief Engineer (SCM)**. Those who notice any discrepancy or have any suggestion regarding revision, may bring the matter to the attention of Chief Engineer (SCM) in writing or through e-mail id:**cescm@kseb.in**



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Annexure – I

Technical Specifications

- 1 **Scope:-** This specification is intended to cover the design manufacture, assembly, testing at Manufacture's works, supply and delivery of **Inductive Voltage Transformers (Potential Transformers)** for metering and relaying service in 220kV and 110kV 3 phase system with secondary voltage of 110/√3 volts.
- 2 **Standards:-** Unless otherwise specified else where in this specification, the voltage transformers shall conform to all respect to the latest revisions and amendments to Indian standards **IS: 16227 / IEC: 61869**, IS:3156 Part-I to IV, IEC:60044(4), IS:3347. Equipment meeting any other authoritative standard, which ensures an equal or better quality than the standards, mentioned above, is also acceptable.
- 3 **Type and Rating:-** The **Inductive Voltage Transformers (Potential Transformers)** shall be of outdoor type, single phase oil immersed self cooled suitable for operation in 3 phase solidly grounded system under the climatic condition specified.

The 220kV and 110kV **Inductive Voltage Transformers (Potential Transformers)** shall have the following Ratings:

Sl.No	Particulars	220kV IVT (PT)	110kV IVT (PT)
1)	Nominal system voltage	220kV	110kV
2)	Highest system voltage	245kV	123kV
3)	Frequency	50Hz	50Hz
4)	Earthing	Effective	Effective
5)	No of secondary windings	3	3
6)	Ratio	$\frac{220kV}{\sqrt{3}}$ $\frac{110V}{\sqrt{3}} / \frac{110V}{\sqrt{3}} / \frac{110V}{\sqrt{3}}$	$\frac{110kV}{\sqrt{3}}$ $\frac{110V}{\sqrt{3}} / \frac{110V}{\sqrt{3}} / \frac{110V}{\sqrt{3}}$



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Sl.No	Particulars	220kV IVT (PT)	110kV IVT (PT)
7)	Rated burden (not less than)	150 VA for core I & II and 100VA for core III	150 VA for core I & II and 100VA for core III
8)	Simultaneous burden	Accuracy has to be confirmed with simultaneous loading of all windings.	Accuracy has to be confirmed with simultaneous loading of all windings.
9)	Class of accuracy (IS)	3P for core I & II protection and 0.2 for core III metering	3P for core I & II protection and 0.2 for core III metering
10)	Basic insulation level	1050kVp	550kVp
11)	Minimum creepage distance of porcelain housing (mm)	6125	3100
12)	One minute dry power frequency withstand primary voltage kV (rms)	460	230
13)	Rated voltage factor	1.2 continuous.1.5 for 30 sec	1.2 continuous.1.5 for 30 sec
14)	Max. temperature rise over ambient of 40 degree Celsius	As per IS:16227 / IEC:61869	As per IS:16227 / IEC:61869
15)	Application	Protection and metering	Protection and metering
16)	No. of terminals in control cabinet	All contacts and control circuits to be wired up to control panel plus 20% extra terminals exclusively for owner's use	All contacts and control circuits to be wired up to control panel plus 20% extra terminals exclusively for owner's use



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Sl.No	Particulars	220kV IVT (PT)	110kV IVT (PT)
17)	Standard reference voltage for which accessories are valid	90% to 103% for protection, 99% to 101% for metering	90% to 103% for protection, 99% to 101% for metering

4 Climatic Conditions:-

The Climatic Conditions prevailing at site are as follows:

Maximum temperature of Air in shade	: 40 C.
Minimum temperature of air in shade	: 15 C
Maximum relative humidity	: 100 %
Average no. of thunderstorm days per annum	: 50
Average no. of rainy days per annum	: 180
Average annual rainfall	: 3000mm
Maximum wind pressure	: 100kg/m ²
Altitude not exceeding	: 1000M

- 5 **General:-** The voltage transformers shall be oil immersed and self cooled suitable for the service indicated complete in all respects conforming to the modern practice of design and manufacture. The core shall be of high grade, non-ageing, Electrical silicon laminated steel of low hysteresis loss and high permeability to ensure high accuracy of both normal and over voltages.

The voltage transformers shall be sealed to eliminate breathing and prevent air and moisture from entering the tank. These shall be provided with oil level gauge and shall be provided with pressure relieving devices capable of releasing abnormal pressure.

The oil filled bushing shall be provided with lifting arrangements, oil filling and drain plugs, oil sight glass etc... They shall ensure ample insulation, Mechanical strength and rigidity for operation under site conditions.

Terminal box shall be hot dip galvanized. Polarity marks shall be indelibly be marked on each Inductive Voltage transformer (Potential Transformer) and at the lead terminals at the



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associated terminal block. Secondary circuit shall be protected by HRC fuses and all the fuses shall be inside the terminal box.

6 Windings:-

6.1 **Primary Winding:-** All primaries of voltage transformers will be connected in phase to neutral with the neutral point solidly earthed. The neutral of the system is also solidly earthed. The primary winding shall be of Hard Drawn Electrolytic copper. The neutral point (N) of the primary winding shall be terminated on terminal having voltage rating not less than 3kV. It shall be connected firmly to GROUND. The NEUTRAL point/terminal shall be legibly marked as N with grounding symbol. It shall be possible to remove connection to ground for testing the VT.

6.2 **Secondary Winding:-** The 220kV and 110kV Inductive Voltage transformer (Potential Transformer) shall be provided with three separate windings rated for 63.5 V. The winding (63.5V) to be used for metering and relaying shall be of accuracy class specified for appropriate class. The rated burden of these winding shall not be less than the specified values. The secondary winding shall be of Hard Drawn Electrolytic copper.

7 Secondary Terminal Box:

VT secondary windings shall be brought out in weatherproof terminal box. The terminal box shall be provided with removable gland plates having 3 No's of cable glands. Cable gland shall be suitable for accommodating 1100 V grade PVC insulated Steel wire armored PVC sheathed two core stranded 4 mm² copper conductor control cable. Dimension and opening of box shall be adequate for easy access and working space with normal tool. Properly rated HRC fuses shall be provided for each secondary winding. Connect well make 32 A CST terminal connector shall be used for terminating leads from VT secondary winding and outgoing cables. The terminal box shall be made of GI, aluminium alloy castings or other alloy which has inherent property of prevent rusting. IP rating for the enclosure shall be IP 54 or better.

8 **Insulation:-** The Inductive Voltage transformer (Potential Transformer) shall withstand satisfactorily dielectric test voltage corresponding to basic insulation level of 1050kVp for 220kV, 550 kVp for 110kV.



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9 Temperature Rise:- The voltage transformers shall be designed to limit the temperature of windings and other parts as specified in the standards IS:16227 / IEC:61869 when corrected for the difference between the temperature prevailing at site and temperature specified by the standards. The temperature rise at 1.2 times rated primary voltage when applied continuously at rated frequency and at rated burden shall not exceed the limits specified above and the temperature rise at 1.5 times rated primary voltage when applied for 30 seconds starting from previous stable operating condition at rated frequency and rated burden shall not exceed the above temperature limits by more than 10°C.

10 Tank:- The metal tank shall have minimum number of welded joints and shall be made of mild steel. The metal tank including top cover shall be coated with coats of Zinc rich epoxy painting of thickness 50 microns. All ferrous parts shall be hot dip galvanized. The dome shall be made of Aluminium or stainless steel in order to prevent corrosion. Expansion chamber at the top of the porcelain insulator should be suitable for expansion of oil and provision of primary terminals. Between expansion chambers of primary terminals leak proof and temperature resistant five play gasket shall be used.

11 Gasket:- Gaskets of nitrile rubber or equivalent shall be used to ensure perfect oil tightness.

Characteristics shall be:

11.1	Specific gravity	:	0.7 to 0.8
11.2	Hardness, IRHD	:	70 ± 5
11.3	Compressibility at 28 Kg/cm ² , %	:	30 ± 5 (for 6.4 ^t) 33 ± 5 (for 9.6 ^t)
11.4	Compressibility at 60Kg/ cm ² , %	:	40 ± 5 (for 6.4 ^t) 45 ± 5 (9.6 ^t)
11.5	Recovery at 28Kg/ cm ² , % minimum	:	80
11.6	Recovery at 60 Kg / cm ² , % minimum	:	70
11.7	Tensile strength, Kg/ cm ² , minimum	:	18
11.8	Compression set % maximum	:	80 (Temp. 110 to 120°C)
11.9	Flexibility	:	Shall pass



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- 11.10 Chemical test on water extract :
- a) pH : 5 to 8
 - b) Chloride content, as Chloride iron : 0.2% maximum
 - c) Sulphate content, as Sulphate iron : 0.2 % maximum.

The gaskets provided on all openings of IVTs (PTs) should be clamped properly with stoppers of optimum torque to avoid permanent setting, no over tightening should be carried out causing loss of spring effect. Porcelain bottom gaskets shall be placed on suitable grooves.

- 12 **Insulating Oil:-** The quantity of insulating oil for first filling of oil in each transformer and the complete specifications of the oil in each shall be stated. The Oil shall conform to the requirements of Indian standard IS:335. Subject to the requirements of the contractors specification being fulfilled the actual oil to be used shall be at the discretion of the purchaser.

- 13 **Type of Mounting:-** The Inductive Voltage transformers (Potential Transformers) shall be suitable for mounting on galvanized steel structures. The necessary flanges, bolts etc... for the base of the voltage transformers shall be supplied and these shall be galvanised. Supply of structure for 110kV IVTs (PTs) & 220kV IVTs (PTs) with suitable foundation bolts are included in the scope of supply.

The height of the 220kV and 110kV Supporting structure shall be such that clearance between ground and live part shall not be less than **5.6 m and 4.60m** respectively.

Adequate factor of safety shall be provided in the design of structure. The structure shall be of Lattice or tubular type with adequate mechanical strength covering ASTM standard.

The structures shall be suitable to fix on foundation bolts having size (dia. Shall be 24mm.) with a spacing of 400mm x 400mm, both ways (for 110kV and 220kV). The height of the structure shall be such as to meet the ground clearances for the respective voltage class. That is, Height of structure + height of the supporting insulator of the IVT up to live portion shall be 5600mm & 4600mm. (minimum) for 220kV & 110kV IVTs respectively.

- 14 **Terminal Connections:-** Bimetallic Terminal connectors suitable for ACSR Double Moose with a spacing of 250mm for 220kV and ACSR Kundah for 110kV shall be supplied. Suitable terminal earth connections shall also be supplied.



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15 Name / Rating plate:- Each Inductive Voltage transformer (Potential Transformer) shall be provided with a name plate legibly marked with the following in addition to that specified as per IS: 16227 / IEC: 61869.

Rated voltage ratio

Name of manufacturer

Type, designation and serial no.

Rated voltage and frequency

P.O. No. and date.

Relevant Standard: IS:16227 / IEC:61869

Guarantee Period: 30/36

Total Weight of Copper.

16 Type tests:- Such of these types tests for which facilities exists in manufacturers premises shall be conducted in one Inductive Voltage transformer (Potential Transformer) tested at random. Routine tests shall be carried out by the manufacturers on all complete voltage transformers as per IS:16227 / IEC:61869 (Latest edition). These tests shall be conducted in the presence of KSEB Limited's Engineers if so required. Certified copies of the test reports shall be sent to the purchaser for approval. A schedule of standard routine tests being carried out by the manufacturers shall be submitted. Copies of type test reports and sample test reports on prorated sections and complete voltage transformers should be supplied. List of type tests & special test as per IS:16227 / IEC:61869 are

16.1 Type Tests:-

16.1.1. Temperature-rise test.

16.1.2. Impulse voltage test on primary terminals.

16.1.3. Wet test for outdoor type transformers.

16.1.4. Test for accuracy or other characteristics – appropriate class.

16.1.5. Short-circuit withstand capability test.

16.1.6. Electromagnetic compatibility test

16.1.7. Verification of degree of protection by enclosures.



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16.1.8. Type test on hollow insulator as per IS: 5621:

16.1.8.1. Visual Inspection.

16.1.8.2. Electrical Routine test.

16.1.8.3. Verification of dimensions.

16.1.8.4. Porosity test.

16.1.8.5. Temperature Cycle Test.

16.2 Special Tests:- :-

16.2.1. Chopped impulse voltage withstand test on primary terminals – as Type test.

16.2.2. Internal arc fault test – as Type test.

17 Routine Tests:- Each Inductive Voltage transformer (Potential Transformer) shall be subjected to routine tests as specified in IS:16227 / IEC:61869 including 24 hours pressure test to check for leakage in the presence of Purchaser's representative if so desired by the purchaser. All test reports should be submitted and got approved by the purchaser before despatch of the equipment. List of routine tests as per IS: 16227 / IEC: 61869 are:

17.1. Verification of markings.

17.2. Power-frequency voltage withstand tests on primary terminals.

17.3. Power-frequency voltage withstand tests on secondary terminals.

17.4. Partial discharge measurement.

17.5. Test for accuracy – appropriate class.

17.6. Measurement of capacitance and dielectric dissipation factor.

17.7. Power frequency voltage withstand test between sections.

18 Documentation:-

All drawings shall conform to International Standards Organisation (ISO) 'A' series of drawing sheet / Indian Standards Specification. All dimensions and data shall be in S.I units.



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List of Drawings and Documents:- The bidder shall furnish four sets of following drawings / documents along with the offer.

- a) General outline and assembly drawing of the equipment.
- b) Name Plate.
- c) Schematic drawing, Typical.
- d) Supporting structure and foundation drawings.
- e) Terminal connector

The supplier shall, within 2 weeks of placement of order, submit four sets of final versions of all the above said drawings for purchaser's approval. The purchaser shall communicate his comments / approval on the drawings to the supplier. The supplier shall, if necessary, modify the drawings and resubmit four copies of the modified drawings for approval.

Copies of the type test reports, duly approved by the purchaser, shall be submitted by the supplier for distribution before commencement of supply. Adequate copies of acceptance and routine test certificates, duly approved by the purchaser, shall accompany the despatch consignment.

The manufacturing of the equipment shall be strictly in accordance with the approved drawings and no deviation shall be permitted without the written approval of the purchaser. All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawing shall be at the supplier's risk.

Copies of nicely printed and bound volumes of operation, maintenance and erection manuals in English language, for each type and rating of equipment supplied shall be submitted by the supplier for distribution, prior to the dispatch of the equipment. The manual shall contain all the drawings and information required for erection, operation and maintenance of the equipment. The manual shall also contain a set of all the approved drawings, type test reports etc...



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Approval of drawings / work by purchaser shall not relieve the supplier of his responsibility and liability for ensuring correctness and correct interpretation of the drawings for meeting the requirements of the latest revision of application standards, rules and codes of practices. The equipment shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of ordering and purchaser shall have the power to reject any work or materials which, in his judgment is not in full accordance therewith.

- 19 Inspection Testing Plan:** - The Inspection Testing Plan should be prepared and sent to this office in advance along with submission of drawings for approval including the QA / QC in material procurement & manufacturing.

Sd/-

Chief Engineer (SCM & CSC)



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Annexure-II – Guaranteed Technical Particulars

**for 220kV IVT (PT), Supporting Structure for 220kV IVT (PT), 110kV IVT (PT) & Supporting Structure
for 110kV IVT (PT)**

Description	220kV IVT (PT)	110kV IVT (PT)
1. Type		
2. Manufacturer's Type & Designation		
3. Rated Primary Voltage (kV)		
4. Number of Secondary Windings		
5. Rated Secondary Voltage (V)		
a) Winding-I		
b) Winding-II		
c) Winding-III		
6. Rated Burden (VA)		
a) Winding-I		
b) Winding-II		
c) Winding-III		
d) Simultaneous Burden (VA)		
7. Accuracy Class		
a) Winding-I		
b) Winding-II		
c) Winding-III		
8. Maximum Phase Angle Error with Rated Burden at 5% Normal Primary Voltage		



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Description	220kV IVT (PT)	110kV IVT (PT)
9. Maximum Ratio Error with Rated Burden at 5% Normal Primary Voltage		
10. Grade of Oil as per IS:335		
11. Temperature Rise with Rated Burden (°C)		
a) at 1.2 times Rated Voltage		
b) at 1.1 times Rated Voltage		
12. Rated Voltage factor and Time (1.2 continuous & 1.5 for 30 sec.)		
13. Temperature rise for (12) above °C		
14. One minute Power frequency withstand voltage (kVrms)		
a) Wet		
b) Dry		
c) On Secondaries		
15. 1.2/50 micro second Impulse wave withstand Test Voltage kVp		
16. Make of Insulator		
17. Creepage Distance (mm)		
18. IP rating for the secondary terminal box		
19. Type tests – Complied and test report attached?		
a) Temperature-rise test		
b) Impulse voltage test on primary terminals		
c) Wet test for outdoor type transformers		



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Description	220kV IVT (PT)	110kV IVT (PT)
d) Test for accuracy or other characteristics – appropriate class		
e) Short-circuit withstand capability test		
f) Electromagnetic compatibility test		
g) Verification of degree of protection by enclosure		
h) Chopped impulse voltage withstand test on primary terminals		
i) Internal arc fault test		
j) Type test on hollow insulator as per IS: 5621		
1. Visual Inspection		
2. Electrical Routine test		
3. Verification of dimensions		
4. Porosity test		
5. Temperature Cycle Test		
20. Weight of Oil (kg)		
21. Total Weight (kg)		
22. Overall Dimensions		
23. Mounting Details		
24. Weight of Supporting Structure		
25. Thickness of Galvanization of Supporting Structure		
26. Additional Information, if any.		

Name and Address of Bidder