



SUPPLY CHAIN MANAGEMENT

THIRUVANANTHAPURAM

SPECIFICATION

220KV & 110KV CAPACITOR VOLTAGE TRANSFORMER

APPLICABLE TO KSEBL	Rev#1	DOC. NO.: SCM-SPEC/XT/220kv & 110kv CVT
		EFF. DATE: 25/07/2022

Number of Pages: 19

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Rev.#: 1

Effective Date 25/07/2022

(i) Document Approval & Control Status:(R0)

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(ii) Amendments and History

Sec. #	Rev. #	Date	History of Change
2, 4.10, 4.13, 14, 15	R1	12/07/2022	IS/IEC Standard corrected
3	R1	12/07/2022	110kV CVT core corrected from 2 to 3. Ratio, burden accuracy class corrected for 110kV PT
5	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 Capacitor Voltage Transformer** 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 Capacitor Voltage Transformer** 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**



SUPPLY CHAIN MANAGEMENT

Thiruvananthapuram

TECHNICAL SPECIFICATION

220KV & 110KV CAPACITOR VOLTAGE TRANSFORMER

Doc. #: SCM-SPEC/XT/220kV & 110kV CVT

Rev.#: 1

Effective Date 25/07/2022

CONTENTS

1) Scope:	6
2) Standards	6
3) Type and Rating	7
4) GENERAL TECHNICAL REQUIREMENTS	8
5) Tests:	12
6) Inspection Testing Plan:	
7) Guaranteed Technical Particulars	14



SUPPLY CHAIN MANAGEMENT

Thiruvananthapuram

TECHNICAL SPECIFICATION

220KV & 110KV CAPACITOR VOLTAGE TRANSFORMER

Doc. #: SCM-SPEC/XT/220&110kV CVT

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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 Capacitor Voltage Transformers for metering and relaying service in 220kV and 110kV 3 phase system with secondary voltage of 110/ $\sqrt{3}$ volts.
- 2 Standards:-**
 - 2.1 IS: 16227 / IEC: 61869 Instrument Transformers
 - 2.2 IS : 3156 (Part-I to III) Voltage Transformer
 - 2.3 IS : 3156 (Part-IV) Capacitor Voltage Transformer
 - 2.4 IS : 2099 High Voltage porcelain bushing.
 - 2.5 IS : 3347 Dimensions of porcelain transformer bushings.
 - 2.6 IS : 2071 Method of High Voltage Testing
 - 2.7 IS : 335 Insulating oil for transformers and switchgears
 - 2.8 IS : 2165 Insulation Co-ordination for equipment of 100 kV and above.
 - 2.9 IS : 2147 Degree of protection provided by enclosures for low voltage switchgear and control
 - 2.10 IEC- 186,186A. 44(2) Voltage Transformers
 - 2.11 IEC – 270 Partial discharge Measurement
 - 2.12 IS - 5561 Terminal Connectors
 - 2.13 IS -4800 Enameled round winding wires
 - 2.14 IEC- 44 (4) Instrument Transformer measurement of PDs
 - 2.15 IEC-60071 Insulation Co-Ordination
 - 2.16 IEC – 358 Coupling capacitor divider.
 - 2.17 IEC-60060 High Voltage testing techniques.
 - 2.18 IEC-8263 Method for RIV test on high voltage insulators.
 - 2.19 IS: 9348 Coupling capacitors and capacitor dividers
 - 2.20 IS: 2633 Methods of testing hot dipped galvanized articles
 - 2.21 IS: 11065 Drawings.
 - 2.22 IS: 5621 Hollow porcelain insulators
 - 2.23 CEA Regulations 2006 Installation & Operation of Meters



SUPPLY CHAIN MANAGEMENT

Thiruvananthapuram

TECHNICAL SPECIFICATION

220KV & 110KV CAPACITOR VOLTAGE TRANSFORMER

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Effective Date/04/2022

Equipment meeting with the requirements of other authoritative standards, which ensure equal or better performance than the standards mentioned above, shall also be considered. When the equipment offered by the supplier conforms to other standards salient points of difference between standards adopted and the standards specified in this specification shall be clearly brought out in the relevant schedule. Four copies of such standards with authentic translation in English shall be furnished along with the offer.

- 3 Type and Rating:-** The Capacitor voltage 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 ambient temperature class of -5/40°C shall be adopted. The 220kV and 110kV Capacitor voltage transformers shall have the following Ratings:

Particulars	220kV CVT	110kV CVT
1. Nominal system voltage	220kV	110kV
2. Highest system voltage	245kV	123kV
3. Frequency	50Hz	50Hz
4. Earthing	Solidly Earthed	Solidly Earthed
5. No of secondary windings	3	3
6. Ratio	$\frac{220kV}{\sqrt{3}}$ $\frac{110V}{\sqrt{3}} / \frac{110V}{\sqrt{3}} / \frac{110V}{\sqrt{3}}$	$\frac{110kV}{\sqrt{3}}$ $\frac{110V}{\sqrt{3}} / \frac{110V}{\sqrt{3}} / \frac{110V}{\sqrt{3}}$
7. Rated burden (not less than)	100 VA for core I & II and 50VA for core III	100 VA for core I & II and 50VA 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



SUPPLY CHAIN MANAGEMENT

Thiruvananthapuram

TECHNICAL SPECIFICATION

220KV & 110KV CAPACITOR VOLTAGE TRANSFORMER

Doc. #: SCM-SPEC/XT/220&110kV CVT

Rev.#: 1

Effective Date/04/2022

Particulars	220kV CVT	110kV CVT
11. Minimum creepage distance of porcelain housing (mm)	6125	3100
12. One minute dry power frequency withstand primary voltage kV (rms)	460	230
13. One minute power frequency withstand for secondary winding in kV (rms)	3	3
14. Equivalent capacitance at power frequency for carrier coupling for CVT (minimum)	8800pF	8800pF
15. Rated voltage factor	1.2 continuous.1.5 for 30 sec	1.2 continuous.1.5 for 30 sec
16. Max. temperature rise over ambient of 40 degree Celsius	As per IS: 16227 / IEC: 61869	As per IS: 16227 / IEC: 61869
17. Application	Protection and metering	Protection and metering

3.1 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



SUPPLY CHAIN MANAGEMENT

Thiruvananthapuram

TECHNICAL SPECIFICATION

220KV & 110KV CAPACITOR VOLTAGE TRANSFORMER

Doc. #: SCM-SPEC/XT/220&110kV CVT

Rev.#: 1

Effective Date/04/2022

4 GENERAL TECHNICAL REQUIREMENTS:-

- 4.1** The insulation of the instrument transformers shall be so designed that the internal insulation shall have higher electrical withstand capability than the external insulation. The designed dielectric withstands values of external and internal insulations shall be clearly withstand values specified in this guaranteed technical particulars. The dielectric withstand values specified in this specification are meant for fully assembled instrument transformers. The insulation resistance value shall be greater than $5G\Omega$ at 5kV DC. Tan delta value shall be less than 0.5% at ambient temperature.
- 4.2 Porcelain Housing:-** The details of location and type of joint, if provided on the porcelain, shall be furnished by the supplier along with the offer. The housing shall be made of homogeneous, vitreous porcelain of high mechanical and dielectric strength, glazing of porcelain shall be of uniform brown or dark brown colour with a smooth surface arranged to shed away rain water or condensed water particles (fog).
- 4.3** Details of attachment of metallic flanges to the porcelain shall be brought out in the offer.
- 4.4** The metal tanks shall have bare minimum number of welded joints so as to minimise possible locations of oil leakage. The metal tanks shall be made out of mild steel / Stainless steel / aluminium alloy, depending on the requirement. Welding in horizontal plane is to be avoided as welding at this location may give way due to vibrations during transport resulting in oil leakage. Supplier has to obtain specific approval from purchaser for any horizontal welding used in the bottom tank.
- 4.5 Surface Finish:-** The ferrous parts exposed to atmosphere shall be hot dip galvanised or shall be coated with at least two coats of zinc rich epoxy painting. All nuts, bolts and washers shall be made out of stainless steel.
- 4.6 Insulating Oil:-** Insulating oil required for first filling of the instrument transformer shall be covered in supplier's scope of supply. The oil shall meet the requirements of latest edition IS:335 or equivalent IEC.
- 4.7 Prevention of Oil leakages and Entry of Moisture:-**
- 4.7.1** The supplier shall ensure that the sealing of instrument transformer is properly achieved. In this connection the arrangement provided by the supplier at various locations including the following ones shall be described, supported by sectional drawings.
- Locations of emergence of primary and secondary terminals.
 - Interface between porcelain housing and metal tanks.
- 4.7.2** Nuts and bolts or screws used for fixation of the interfacing porcelain bushings for taking out terminals, shall be provided on flanges cemented to the bushings and not on the porcelain.



SUPPLY CHAIN MANAGEMENT

Thiruvananthapuram

TECHNICAL SPECIFICATION

220KV & 110KV CAPACITOR VOLTAGE TRANSFORMER

Doc. #: SCM-SPEC/XT/220&110kV CVT

Rev.#: 1

Effective Date/04/2022

4.7.3 For gasketed joints, wherever used nitrile butyl rubber gaskets shall be used. The gasket shall be fitted in properly machined groove with adequate space for accommodating the gasket under compression.

4.8 Oil level indicators:- Instrument transformers shall be provided with oil sight window (Prismatic Type) at suitable location so that the oil level is clearly visible with naked eye to an observer standing at ground level.

4.9 Earthing:- Metal tank of the instrument transformer shall be provided with two separate earthing terminals for bolted connection to 75 X 10 mm 50 X 6mm GI flats for 220 KV and 110 KV respectively, for connection to station earth-mat.

4.10 Instrument transformer shall be provided with suitable lifting arrangement, to lift the entire unit. The lifting arrangement shall be clearly shown in the general arrangement drawings. Lifting arrangement (lifting eye) shall be positioned in such a way so as to avoid any damage to the porcelain housing or the tanks during lifting for installation / transport. If necessary, string guides shall be offered which shall be of removable type.

4.11 Name plate: The instrument transformer shall be provided with non-corrosive, legible name plate with the information specified in IS: 16227 / IEC: 61869, duly engraved / punched on it. In addition to these P.O. NO.& Connection diagram shall also be marked in rating plate.

4.12 Secondary Terminal box:

The 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 CVT 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.

4.13 Terminal connector: 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 connectors for earthing connections shall also be provided.

4.13.1 The terminal connectors shall meet the following requirements:

- 1) Terminal connectors shall be manufactured and tested as per IS:5561 or equivalent IEC.
- 2) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.
- 3) No part of a clamp shall be less than 10mm thick.

- 4) All ferrous parts shall be hot dip galvanized conforming to IS:2633 or equivalent IEC.
- 5) For bimetallic connectors, copper alloy liner of minimum 2mm thickness shall be cast integral with aluminium body.
- 6) Flexible connectors shall be made from tinned copper / aluminium sheets.
- 7) All currents carrying parts shall be designed and manufactured to have minimum contact resistance.
- 8) Connectors shall be designed to be corona free in accordance with the requirements stipulated in IS: 5561 or equivalent IEC.

4.14 Enamel, if used for conductor insulation, shall be polyvinyl acetate type or amideemide type and shall meet the requirements of IS:4800 or equivalent IEC. Polyester enamel shall not be used. Double cotton cover, if used, shall be suitably covered to ensure that it does not come in contact with oil.

4.15 The temperature rise on any part of equipment shall not exceed maximum temperature rise specified in IS:16227 or equivalent IEC. However, the permissible temperature rise indicated is for a maximum ambient temperature of 40°C.

4.16 The instrument transformers shall be so constructed that it can be easily transported to site within the allowable transport limitation and in horizontal position, if the transport limitations so demand.

4.17 The instrument transformers shall be vacuum filled with oil after processing and thereafter hermetically sealed to eliminate breathing and to prevent air and moisture from entering the tanks, sealing type oil filling and / or oil sampling cocks shall be provided with facility to reseal the same. The method adopted for hermetic sealing shall be described in the offer.

4.18 Suitable arrangement shall be made to accommodate the expansion and contraction of oil due to temperature variation. The pressure variation shall be kept within limits which do not impair the tightness of the instrument transformer. A pressure relief device capable of releasing abnormal internal pressure shall be provided.

4.19 The CVTs comprising of a capacitor divider unit and electromagnetic unit shall be single phase, oil filled hermetically sealed, self cooled, outdoor type and suitable for direct line connection without any fuse and isolating switches, These CVTs are required to be used on interlinking substations in power system for the purpose of protection, synchronising, interlocking, carrier coupling and metering. CVTs shall be suitable for connecting the carrier terminals to single circuit and double circuit transmission lines for phase to phase coupling for power line carrier, voice communication, telemetering services.

4.20 The secondary terminals of potential unit, high frequency coupling terminal and the earthing terminals shall be brought out separately and housed in a water proof cabinet outside the main steel chamber.



SUPPLY CHAIN MANAGEMENT

Thiruvananthapuram

TECHNICAL SPECIFICATION

220KV & 110KV CAPACITOR VOLTAGE TRANSFORMER

Doc. #: SCM-SPEC/XT/220&110kV CVT

Rev.#: 1

Effective Date/04/2022

- 4.21** The capacitor voltage transformer shall be suitable for simultaneous use as measuring unit, for feeding voltage supply to protective relays and as coupling capacitor for carrier transmission i.e. for voice communication, carrier protective relays, telemetering, teleprinting services over one or more carrier channels in the frequency range of 40 to 500KHz.
- 4.22** The capacitors shall be designed for wide frequency band and low dielectric loss. Their natural frequency shall be considerably higher than the carrier frequency range of 40 KHz to 500 KHz.
- 4.23** The unit capacitors shall be so designed that no damage to internal elements or change in electrostatic capacitance is resulted by the application of impulse voltage.
- 4.24** Each CVT including its EMU shall be filled with insulating oil conforming to IS:335 or equivalent IEC. And shall be hermetically sealed against moisture and dust.
- 4.25** The electromagnetic voltage transformer unit of CVT intended for out-door installation whose primary is to be fed by the inter-mediate tapping of capacitor divider shall be of oil immersed, self cooled design and shall be suitable for metering, relaying & synchronising services. The core of this transformer shall be of high accuracy at normal & high voltages. The primary winding shall be connected through a compensating reactor to compensate the voltage increase at inter-mediate tapping, whatever is the load within range of rated burden.
- 4.26** The design shall be free from corona effect to keep noise level of carrier frequency link very low. Use may be made of grading rings or Electrostatic screen for this purpose if required.
- 4.27** The design shall be suitable for rapid re-closing of the circuit and shall be capable of accurate and proportionate transmission of sudden variation in the primary voltage.
- 4.28** Each CVT shall be provided with a suitable damping device so that ferro-resonance oscillation due to saturation of iron core of transformer or any inductance connected in parallel with it and initiated by either over voltages on the net work side or by opening of the short circuited primary or secondaries, shall be practically zero. Oscillations of the secondary voltages which may arise as a result of breakdown of primary voltages due to short circuits shall not affect the proper working of protective relays.
- 4.29** Design of the potential units of the CVT shall be based on the following requirements in connection with protective relaying.
- 4.29.1** They must transmit accurately sudden drops of primary voltage.
- 4.29.2** The CVTs must not enter into sub-harmonic resonance and transient oscillations during energisation. They must be damped out with sufficient rapidness.
- 4.29.3** They must have sufficiently low short circuit impedance as seen from secondary.
- 4.30** A device shall be incorporated in a capacitor voltage transformer for the purpose of limiting over voltages which may appear across one or more of its components and / or to prevent sustained ferroresonance. The device may include a spark gap and may be located in several



SUPPLY CHAIN MANAGEMENT

Thiruvananthapuram

TECHNICAL SPECIFICATION

220KV & 110KV CAPACITOR VOLTAGE TRANSFORMER

Doc. #: SCM-SPEC/XT/220&110kV CVT

Rev.#: 1

Effective Date/04/2022

different ways according to its nature. (Clause 2.12 of IS:3156 (Part-IV)-1978 or IEC-186A Clause 37.12)

4.31 Suitable terminal boxes with removable gland plate for facilitating the entry of H.F. Cable & VT control cables shall be provided at an accessible position.

4.32 The secondary terminals shall be brought out in a weather proof terminal box and it shall be provided with a removable gland plate. Each secondary core shall be provided with MCB / Fuse protection. Also suitable arrangements may be provided for earthing the CVT neutral in the event of opening the secondary terminal box cover.

4.33 Supporting Structure:

Supply of structure for 110kV & 220kV CVTs with suitable foundation bolts are included in the scope of supply.

The CVTs shall be suitable for mounting on galvanized steel structures. The structure shall be tubular or lattice type. The necessary flanges, bolts etc. for the base of the voltage transformers shall be supplied and these shall be galvanized.

The height of the supporting structures for 220kV and 110kV CVTs shall be such that clearance between ground and live part of the CVTs 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 CVT up to live portion shall be 5600mm & 4600mm. (minimum) for 220kV & 110kV CVTs respectively.

5 Tests:-

The offered product shall be type tested as per IS:16227 and IEC:61869 at Government of India Lab or lab accredited by “National Accreditation Board for testing and Calibration Lab” and shall comply with all relevant standards. The Bidder must submit copies of Type test reports with the bid as per latest edition of IS:16227, IEC:61869. Each CVT shall be subjected to routine tests as specified in Indian Standard 16227, IEC.61869. All routine tests shall be made prior to dispatch in the presence of the representative of the purchaser if so desired by the purchaser and the test results in quadruplicate shall be supplied to the purchaser for approval. Also 24 hours pressure test to check for leakage shall be done in the presence of Board’s representative if so desired by the Board. Test report of CVT shall be submitted before offering for FAT. All routine tests shall be carried out on 10% of the quantity as per standard acceptance procedure.



SUPPLY CHAIN MANAGEMENT

Thiruvananthapuram

TECHNICAL SPECIFICATION

220KV & 110KV CAPACITOR VOLTAGE TRANSFORMER

Doc. #: SCM-SPEC/XT/220&110kV CVT

Rev.#: 1

Effective Date/04/2022

5.1 TYPE TESTS OF CAPACITOR VOLTAGE TRANSFORMERS (CVT's):-

The equipment offered should be type tested. Test reports in respect of all the tests carried out in accredited laboratories (based on IS 16227/ IEC 61869) by a reputed accreditation body or witnessed by KSEB or another electric power utility and be submitted along with offer.

- 5.1.1 Temperature-rise test.
- 5.1.2 Impulse voltage test on primary terminals.
- 5.1.3 Wet test for outdoor type transformers.
- 5.1.4 Capacitance & tan delta measurement at power frequency
- 5.1.5 Short-circuit withstand capability test
- 5.1.6 Ferro-resonance test.
- 5.1.7 Transient response test
- 5.1.8 Test for accuracy.
- 5.1.9 Electromagnetic compatibility test
- 5.1.10 Verification of degree of protection by enclosures.
- 5.1.11 Type tests for carrier frequency accessories.
- 5.1.12 Type test on hollow insulator as per IS: 5621:
 - 5.1.12.1 Visual Inspection.
 - 5.1.12.2 Electrical Routine test.
 - 5.1.12.3 Verification of dimensions.
 - 5.1.12.4 Porosity test.
 - 5.1.12.5 Temperature Cycle Test

5.2 ROUTINE TESTS:- The following acceptance tests as stipulated in the relevant IS: 16227/IEC 61869 shall be carried out by the Supplier in presence of KSEB representative, unless dispensed with in writing by the KSEB.

- 5.2.1 Verification of markings.
- 5.2.2 Power-frequency voltage withstand tests on primary terminals.
- 5.2.3 Partial discharge measurement.
- 5.2.4 Test for accuracy-appropriate category.
- 5.2.5 Power-frequency voltage withstand tests on secondary terminals
- 5.2.6 Measurement of capacitance and dielectric dissipation factor.
- 5.2.7 Ferroresonance check.
- 5.2.8 Routine tests for carrier frequency accessories.



SUPPLY CHAIN MANAGEMENT

Thiruvananthapuram

TECHNICAL SPECIFICATION

220KV & 110KV CAPACITOR VOLTAGE TRANSFORMER

Doc. #: **SCM-SPEC/XT/220&110kV CVT**

Rev.#: 1

Effective Date/04/2022

5.3 SPECIAL TESTS:- Following tests shall be carried out by the supplier.

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

5.3.2 Transmitted over voltage test-as type test.

6 Inspection Testing Plan: - The Inspection Testing Plan should be prepared and sent to this office in advance before starting manufacturing including the QA / QC in material procurement & manufacturing.

Sd/-

Chief Engineer (SCM &CSC)



SUPPLY CHAIN MANAGEMENT

Thiruvananthapuram

TECHNICAL SPECIFICATION

220KV & 110KV CAPACITOR VOLTAGE TRANSFORMER

Doc. #: SCM-SPEC/XT/220&110kV CVT

Rev.#: 1

Effective Date/04/2022

Annexure-II – Guaranteed Technical Particulars

for 220kV CVT, Supporting Structure for 220kV CVT, 110kV CVT & Supporting Structure for 110kV CVT

Description	220kV CVT	110kV CVT
1) Type		
2) Manufacturer's Type & Designation		
3) Rated Primary Voltage (kV)		
4) Number of Secondary Windings		
5) Rated Capacitance of offered CVT in pF a) C1: b) C2: c) Total Capacitance/Equivalent Capacitance		
6) Rated Secondary Voltage (V)		
1) Winding-I		
2) Winding-II		
3) Winding-III		
2) Rated Burden (VA)		
1) Winding-I		
2) Winding-II		
3) Winding-III		



SUPPLY CHAIN MANAGEMENT

Thiruvananthapuram

TECHNICAL SPECIFICATION

220KV & 110KV CAPACITOR VOLTAGE TRANSFORMER

Doc. #: SCM-SPEC/XT/220&110kV CVT

Rev.#: 1

Effective Date/04/2022

Description	220kV CVT	110kV CVT
3) Accuracy Class		
1) Winding-I		
2) Winding-II		
3) Winding-III		
4) Maximum Phase Angle Error with Rated Burden for 3P Class as per IEC:60044-2		
1) At 5% Normal Primary Voltage		
2) At 80% Normal Primary Voltage		
5) Maximum Ratio Error with Rated Burden for 3P Class as per IEC:60044-2		
1) At 5% Normal Primary Voltage		
2) At 80% Normal Primary Voltage		
6) Grade of Oil as per IS:335		
7) Temperature Rise with Rated Burden (°C)		
1) at 1.2 times Rated Voltage		
2) at 1.1 times Rated Voltage		
8) Rated Voltage factor and Time (1.2 continuous & 1.5 for 30 sec.)		
9) Temperature rise for (12) above °C		



SUPPLY CHAIN MANAGEMENT

Thiruvananthapuram

TECHNICAL SPECIFICATION

220KV & 110KV CAPACITOR VOLTAGE TRANSFORMER

Doc. #: SCM-SPEC/XT/220&110kV CVT

Rev.#: 1

Effective Date/04/2022

Description	220kV CVT	110kV CVT
10) One minute Power frequency withstand voltage (kVrms)		
1) Wet		
2) Dry		
3) On Secondaries		
11) 1.2/50 micro second Impulse wave withstand Test Voltage kVp		
12) Creepage Distance (mm)		
13) 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.		
d) Capacitance & tan delta measurement at power frequency.		
e) Short-circuit withstand capability test		
f) Ferro-resonance test		
g) Transient response test.		
h) Test for accuracy.		
i) Electromagnetic compatibility test		



SUPPLY CHAIN MANAGEMENT

Thiruvananthapuram

TECHNICAL SPECIFICATION

220KV & 110KV CAPACITOR VOLTAGE TRANSFORMER

Doc. #: SCM-SPEC/XT/220&110kV CVT

Rev.#: 1

Effective Date/04/2022

Description	220kV CVT	110kV CVT
j) Verification of degree of protection by enclosures		
k) Type tests for carrier frequency accessories.		
l) Chopped impulse voltage withstand test on primary terminals		
m) Transmitted over voltage test		
n) 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		
14) Weight of Oil (kg)		
15) Total Weight (kg)		
16) Overall Dimensions		
17) IP rating of secondary terminal box		
18) Thickness of Galvanization of supporting Structure		
19) Mounting Details: a) Type: Lattice or Tubular b) If tubular, thickness of the pipe portion in mm		



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Description	220kV CVT	110kV CVT
c) Weight of the supporting structure in Kg. d) Size of foundation bolt. e) Whether foundation bolt is fully galvanized or not.		
20) Additional Information, if any.		

Name and Address of Bidder