



ODISHA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

220,132 & 33 KV IVT

&

400,220 & 132 KV CVT

**TECHNICAL SPECIFICATION
FOR
220 KV, 132KV, 33KV INDUCTIVE VOLTAGE
& 400 KV,220KV,132KV CAPACITIVE VOLTAGE
TRANSFORMERS WITH METERING WINDING OF
ACCURACY CLASS (0.2)**

I- 220KV IVT

II-132KV IVT

III-33KV IVT

IV-400 KV CVT

V-220KV CVT

VI-132KV CVT

TECHNICAL SPECIFICATION FOR 220 KV, 132KV, 33KV INDUCTIVE & 400 KV,220KV,132KV CAPACITIVE VOLTAGE TRANSFORMER

1.0 SCOPE :

Voltage transformers shall be supplied with common marshalling box in a batch of 3 CVT's/ IVT's along with terminal connectors and other fittings for providing necessary inter phase and control room interconnections.

The design of capacitor/Inductive voltage transformers shall be such that its accuracy shall not be affected by the presence of pollution on the external surface of its insulators.

The voltage transformer shall operate satisfactorily in system with high **X/R** ratio.(Tp=100ms)

Voltage transformer tanks along with top metallics shall be galvanised and painted to required shade stipulated under relevant sections of the specification.

1.1 This specification provides for the design, manufacture, assembly inspection and testing at the manufacturer's works, packing and delivery FOR [Destination] of outdoor mounted type, single phase, single unit type Inductive voltage transformers for 220 KV, 132KV & 33KV systems, & Capacitive Voltage Transformers for 400 kv,220kv, 132KV system to be used for voltage indication, supply of potential to tariff meters, relays for feeder protection in Grid Sub-stations of OPTCL, Orissa.. In addition to the above functions the 400 kv,220kv, 132KV CVT shall be suitable for carrier coupling.

1.2 The IVTs shall be complete in all respects with insulators, bimetallic connectors, fixing details etc. as described herein.

1.3 Bidders are required to quote for 0.2 accuracy class [metering winding] for 33KV, 132KV, 220KV IVTs &220kv, 132KV CVTs in the following manner.

- (a) Guaranteed Technical Particulars.
- (b) Technical literatures, brochures and drawings as per this specification.
- (c) Type Test reports.
- (d) List of orders, executed and Users' certificates with offer, failing submission of the above particulars with the offer, the tender may not be considered for evaluation.

2.0 Following is the list of documents constituting this Specification.

- (i) Technical Specification (TS).
- (ii) Technical requirements. - [Appendix-I]
- (iii) Guaranteed Technical Particulars. - [Vol-III]
- (iv) Calibration status of testing equipment and meters/Instruments. - [Annexure-B]
- (vi) Check list towards Type Test Reports.- [Annexure-C]

N.B.:- Annexure-A,B & ,C are to be filled up by the Bidder.

3.0 **STANDARDS:-**

3.1 The IVTs & CVTs shall conform in all respects to high standards of Engineering, design, workmanship and latest revisions of relevant standards at the time of offer and the Purchaser shall have the power to reject any work or material which in his judgement is not in full accordance therewith.

3.2 Except to the extent modified in the specifications, the IVTS & CVTs shall conform to the latest editions and the amendments of the standards listed hereunder:

Sl. No.	Standard Ref. No.	Title.
01	IEC-44(4)	Instrument Transformer – measurement of PDS.
02	IEC-60	High voltage testing techniques.
03	IEC-171	Insulation co-ordination.
04	IEC-186	Voltage Transformers.
05	IEC-186(A)	Voltage Transformers (first supp. to IEC-186)
06	IEC-270	Partial discharge measurement.
07	IS-335	Insulating oil for transformers and switch gears.
08	IEC-8263	Method for RIV Test on high voltage insulators.
09	IS-2071	Method of high voltage testing.
10	IS-2099	High Voltage porcelain bushings.
11	IS-2147	Degree of protection provided by enclosures for low voltage switch-gear and control.
12	IS-2165	Insulation co-ordination for equipments of 100KV and above.
13	IS-3156 (Part-I to IV).	Voltage transformers.
14	IS-3347	Dimensions of porcelain transformer bushings.
15	IS-4146	Application guide for voltage transformers.
16.	IS-5547	Application guide for Capacitor Voltage Transformers.
17.	IS-9348	Coupling Capacitor & Capacitor Devices.

3.3 All the above alongwith the amendments thereof shall be read and interpreted together. However, in case of a contradiction between the Technical Specification and any other volume, the provisions of this Technical Specification will prevail.

3.4 The voltage transformers with the requirements of other authoritative standards, which ensure equal or better quality than the standards, mentioned above shall also be acceptable. Where the equipments, offered by the supplier conforms to other standards, salient points of difference between the standards shall be brought out in the offer. 4 (four) copies of the reference standards in English language shall be furnished alongwith the offer.

3.5 The supplier is to furnish the standards as mentioned above from Sl. 1 to 17 at their own cost, if required by the purchaser.

4.0 CLIMATIC AND SERVICE CONDITIONS :

4.1 The VTS are required to operate satisfactorily under the following conditions.

- (a) Maximum ambient temperature - 50°C.
- (b) Maximum daily average ambient air temperature - 45°C.
- (c) Maximum relative humidity – 100%.
- (d) Average number of rainy days in a year – 120 days.
- (e) Average annual rainfall – 150 cms.
- (f) Altitude not exceeding – 1000 M.
- (g) Maximum wind pressure – 260kg/sq.m.

EARTHQUAKE INCIDENCE:-

The VTS are to be designed to withstand earthquake of an intensity, equivalent to 0.3g in the horizontal and 0.15g in the vertical direction where, ‘g’ stands for acceleration due to gravity.

5.0 PURCHASER’S AUXILIARY POWER SUPPLY:-

5.1 Following power supplies shall be made available at site:

- (a) AC-3 phase, 415V, 50HZ earthed.
- (b) AC single phase, 240V, 50HZ earthed.
- (c) 220V DC, Ungrounded.

5.2 All equipments and devices shall be capable of continuous satisfactory operation on AC and DC supplies of nominal voltage, mentioned above with variations as given below.

- (a) AC voltage variation. $\pm 10\%$
- (b) Frequency variation. $\pm 5\%$.
- (c) Combined voltage & frequency variation. $\pm 10\%$
- (d) DC voltage variation. 190V to 240V DC.

5.3 The supplier shall make his own arrangements for the power supplies other than those specified under Clause-5.1 above.

6.0 INSTALLATION:-

The VTS covered under this specification shall be suitable for outdoor installation without any protection from rain, dust, mist and direct rays of the sun.

7.0. GENERAL TECHNICAL REQUIREMENTS FOR IVT :-

7.1 Each IVT shall be supplied, filled with insulating oil and shall be hermetically sealed to prevent atmosphere coming in contact with oil, avoiding filtration and change of oil. In case

the tenderer intends to use Nitrogen or any other inert gas above the oil level, the gas must not leak out and the same shall be stated in the tender.

7.2 However, the IVT shall have a provision for draining and filling insulating oil after drying or preferably must have arrangement for drying the oil by continuous process with oil filters.

7.3 The IVT shall be suitable for transport in horizontal position if the transport limitations so demand.

SECONDARY TERMINAL BOX:-

1.2.1 The secondary terminals shall be brought out in a weather proof terminal box with a rating not less than IP-55.

1.2.2 All secondary terminals shall be brought out in a compartment on one side of each IVT for easy access. The exterior of this terminal box shall be Aluminum extruded sheets.

1.2.3 The terminal box shall be provided with removable gland plate and glands suitable for 1100 volts grade. PVC insulated, PVC sheathed multi core 4 sq.mm to 6 sq.mm stranded copper conductor cable.

1.2.4 The terminal box shall be provided with a door in front so as to have easy access of secondary terminals. The door shall have a sealing/locking arrangement and shall be suitable to prevent penetration of moisture and rain water.

1.2.5 The dimensions of the terminal box and its openings shall be adequate to enable easy access and sufficient working space for use of normal tools.

1.2.6 The terminal blocks shall be standard type and provided with ferrules indelibly marked or numbered and their identifications shall correspond to the designation on the relevant wiring diagram.

1.2.7 Secondary wiring terminal studs shall be provided with at least three nuts, plain and spring washers. The studs, nuts and washers shall be of brass, duly nickel plated. The minimum diameter of the studs shall be 6 mm. The length of at least 15 mm shall be available on the studs for inserting the leads.

Polarity shall be indelibly marked on each primary and secondary terminals.

1.3 The IVT shall be filled with oil under vacuum after processing and thereafter hermetically sealed to eliminate breathing and to prevent air and moisture from entering the tanks. Oil filling and/or oil sampling cocks, if provided to facilitate factory processing should be properly sealed before despatching the IVT. The method, adopted for hermetic sealing shall be described in the offer.

1.4 The castings of base, collar etc. shall be diecast and tested before assembly to detect cracks and voids, if any.

1.5 The characteristics of the IVTS shall be such as to provide satisfactory performance such as voltage error and phase displacement at rated frequency shall not exceed the values as per relevant standards at any voltage between 80% and 120% of rated voltage and with burdens of between 25% and 100% of rated burden at a power factor of 0.8 lagging. The error shall be determined at the terminals of the IVT and shall include the effects of any fuses or resistors as an integral part of the IVT.

1.6 Inductive voltage transformers shall be designed so as to achieve the minimum risk of explosion in service. The bidder shall bring out in his offer, measures taken to achieve this.

1.7 **PRIMARY WINDING:-**

Primary winding of the IVT will be connected phase to neutral with the neutral point solidly earthed. The arrangement for this shall be included in the scope of supply. The primary conductor shall be of adequate cross-section so that the maximum permissible current density shall not be exceeded even during short-circuit conditions.

7.11 **SECONDARY WINDING.**

Suitably insulated copper wire of electrolytic grade shall be used for secondary windings. The secondary conductor shall be of adequate cross section so that the maximum permissible current density shall not be exceeded even during short- circuit conditions. Each 220KV IVT & 132KV IVT will have two secondary windings, protection-150VA; –Metering-150VA –burden at 0.8 lagging power factor and rated voltage of 110V/1.732V for protection and 110/1.732V for metering winding. Secondary windings shall be used for metering, relaying and synchronizing. Each winding shall comply requirements of both Part-II and III of up-to-date editions of IS-3156/IEC-186. 33KV IVT will have two secondary winding of 75 VA burden at 0.8 lagging power factor and rated voltage 110/1.732 volts(one metering and one protection winding).

7.12 **CORE:-** Core laminations shall be of cold rolled grain oriented silicon steel or other equivalent alloys of low hysteresis and eddy current losses, high permeability to ensure accuracy i.e. 0.2 accuracy class at both normal and high over voltage. The core material , thickness of lamination, the relevant graphs showing the characteristics of the core materials shall be submitted along with the offer.

7.13 **TANK.**

7.13.1 Both expansion chambers and tanks of the IVT shall be made of high quality steel and shall be able to withstand full vacuum and pressure, occurring during transit and thermal and mechanical stresses resulting from maximum short circuit current during operation. The tanks along with all ferrous parts shall be hot- dip galvanized as per relevant standard.

7.13.2 The metal tanks shall have bare minimum number of welded joints so as to minimize possible locations of oil leakage. 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 the purchaser for any horizontal welding, used in the bottom tank

7.13.3 Paint inside the metallic housing shall be of anti-condensation type.

7.14 **PORCELAIN HOUSING.**

7.14.1. The housing shall be made up 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).The details of location and type of joint, if provided on the porcelain, shall be furnished by the Bidder along with the offer.

7.14.2.The bushings of the IVTS shall conform to latest edition of IS-2099.The hollow porcelain insulators shall conform to the latest edition of IS-5621

7.14.3 The insulators shall be cemented with Portland cement to the flanges resulting in high mechanical, tensile and breaking strength

7.14.4. The bushings shall have ample insulation, mechanical strength and rigidity for the condition under which they shall be used and shall be used and shall be designed to prevent accumulation of explosive gases and provide adequate oil circulation to remove the internal heat.

7.14.5 Cast metal and caps for the bushings shall be of high strength hot dip galvanized malleable iron. They shall have smooth surface to prevent discharge taking place between the metal parts and porcelain as a result of ionisation.

7.14.6 The insulation of bushings shall be co-ordinated with that of the IVT such that the flashover, if any, shall occur only external to the IVT.

7.14.7 Oil level gauge and convenient means of filling, sampling and draining of oil shall be provided.

7.14.8 End shields should be provided for distribution of stresses.

7.14.9 Corona shields for bushings, if required, should be provided.

7.15 **INSULATING OIL.**

The quantity of insulating oil for the filling and the complete specification of the insulating oil shall comply in all respects with the provisions of the latest edition of IS-335. The IVTS shall be supplied completely filled with purified oil.

7.16. PREVENTION OF OIL LEAKAGE AND ENTRY OF MOISTURE:-

The supplier shall ensure that the sealing of the IVT 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

- (a) Locations of emergence of primary & secondary terminals..
- (b) Interface between porcelain housing and metal tank(s).
- (d) Cover of the secondary terminal box.

7.16.1 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.

7.16.2 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.

7.17 FITTINGS AND ACCESSORIES:- Fittings and accessories, listed below shall be supplied with each IVT. Any fitting, required essential other than those listed below shall also be supplied along with each IVT.

- (a) Oil level gauge.
- (b) Oil filling hole and cap.
- (c) Pressure relieving device.
- (d) Lifting lugs for core and windings, bushings & complete transformers.
- (e) Phase terminal connectors.
- (f) Tank earthing pads/terminals with necessary nuts and bolts and washers for connecting to Purchaser's strip.
- (g) Name/Rating plate.
- (h) MCB & H.R.C. fuse.

7.18.1 OIL LEVEL GAUGE:- An oil level gauge shall be provided to indicate the oil level in the IVT. This gauge shall be mounted in such a way that the oil level can be seen from the ground level.

7.18.2 PRESSURE RELIEVING DEVICE:- Each IVT shall be provided with a pressure relieving device so as to protect bushing of the IVT even under unfavourable conditions.

7.18.3 OIL DRAIN COCK:- An oil drain cock alongwith a stop cock shall be provided in the bottom flange so as to permit taking of oil samples for testing, if required.

7.18.4 EARTHING:- Metal tank of each IVT shall be provided with two separate earthing terminals for bolted connection to 50mm x 6mm flat to be provided by the Purchaser for connection to station earth-mat.

7.18.5 LIFTING ARRANGEMENT:- The IVT shall be provided with suitable lifting arrangement to lift the entire unit. The lifting arrangement shall be clearly shown in the general arrangement drawing. 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. Necessary string guides shall be offered which shall be of removable type.

7.18.6 NAME PLATE:- The IVT shall be provided with non-corrosive legible name plate with the information specified in relevant standards, duly engraved/punched on it.

7.18.7 GASKET JOINT:- The manufacturer shall furnish the type of gasket used or setting methods.

7.18.8 TERMINAL CONNECTORS:- All the IVTS shall be provided with bimetallic solderless clamp type, rigid type terminal connectors, suitable for ACSR Moose Conductor for 220KV IVT & CVT ACSR .MOOSE /MOOSE Conductor for 132KV, 33KV IVT & 132KV CVT..Each terminal connector shall be of universal type, suitable for both horizontal and vertical connections to the transmission line conductors/station bus bar.

7.18.8.1 TERMINAL CONNECTORS shall be manufactured and tested as per IS:5561.

7.18.8.2 All castings shall be free from blow holes, surface blisters, cracks and cavities.

All sharp edges and corners shall be blurred and rounded off.

7.18.8.3 No part of a clamp shall be less than 10mm thick.

7.18.8.4 All ferrous parts shall be hot dip galvanized conforming to IS-2633.

For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be cast integral with aluminium body.

7.18.8.5 All current carrying parts shall be designed and manufactured to have minimum contact resistance.

7.18.8.6 Connectors shall be designed to be corona free in accordance with the requirements, stipulated in IS-5561.

7.18.9 SECONDARY WIRING:-

The Secondary wiring shall be enclosed in conduits and shall be brought to a terminal block ready for external connections. The wiring shall be of adequate cross-section and not less than 4.00 sq.mm copper wire.

7.18.10 The supplier shall supply necessary hardwares, required for connection of phase side conductor to the line terminal and the grounding strip to the grounding terminal.

7..18.11 Necessary nuts and bolts for fixing the IVTS on the supporting structures shall be in tenderer's scope of supply.

B.7.0 GENERAL TECHNICAL REQUIREMENTS FOR 400 kv,220KV & 132KV CAPACITIVE VOLTAGE TRANSFORMER:-

- 7.1 The design of capacitor voltage transformers shall such that its accuracy shall not be affected by the presence of pollution on the external surface of its insulators.
- 7.2 The CVT shall operate satisfactorily in system with high X/R ratio. (Tp=100 ms).
- 7,3 The CVT transformer tanks along with top metallic shall be galvanized and painted to required shade.
- 7,.4 Impregnation details along with tests and checks to ensure successful completion of impregnation cycle shall be furnished for purchaser's approval.
- 7.5 Bellows, if used to cater for expansion of insulating oil, shall be tested in accordance with relevant standards. The details shall be subject to the approval of the purchaser.
- 7.6 The CVT shall be capacitor voltage type with electromagnetic units and shall be suitable for carrier coupling..
- 7.7 All windings of voltage transformer secondaries shall be protected by MCB and HRC cartridge type fuses. In addition, fuses shall be provided for the protection and metering windings for fuse monitoring scheme. The secondary terminals of the CVTs shall be terminated to stud type non-disconnecting terminal blocks in the individual phase secondary boxes via. the fuse
- 7.8 CVTs shall be suitable for high frequency (HF).coupling, required for power line carrier communication. The carrier signal must be prevented from flowing into potential transformer (EMU) circuit by meant of a RF choke/reactor, suitable for effectively blocking the carrier signal over the entire carrier frequency range i.e. 40 to 500 KHZ. Details of the arrangement shall be furnished along with the bid. HF terminal of the CVT shall be brought out through a suitable bushing and shall be easily accessible for connection to the coupling devices of the carrier communication equipment, when utilized. The bushing shall be fully protected against rain and vermin so as to avoid the possibility of short circuits to earth. An earthing link with fastener shall be provided for HF terminal.
- 7.9 The electromagnetic unit, comprising compensating reactor, intermediate transformer and protective and damping devices should have a separate terminal box with all secondary terminals, brought out.
- 7.10 Voltage transformers should be thermally and dielectrically safe when the secondary terminals are loaded with the guaranteed thermal burdens.

- 7.11 The accuracy of the windings (3P/3P/0.2) shall be maintained through out the entire burden range preferably in the frequency range of 48 HZ to 51.5 HZ on all the three windings without any adjustment during operation. Preference will be given to such bidders who can offer for maintaining the above accuracy class in the frequency range i.e. 48 HZ to 51.5 HZ up to the above specified burden values.
- 7.12 CONSTRUCTIONAL FEATURES:-
- 7.12.1 The 400kv, 220KV & 132KV CVT shall be suitable for mounting on support structure of tubular GI pipe of nominal bore of 300/200 mm. or lattice type structures.
- 7.12.2 Access to secondary terminals shall be possible without any danger of access to high voltage circuit.
- 7.12.3 CVTs shall be hermetically sealed units.
- 7.12.4 A protective surge Arrester/spark gap shall be provided to prevent break down of insulation by incoming surges and to limit abnormal rise of terminal voltage of shunt capacitor/primary winding, turning reactor/RF choke etc. due to short circuit in transformer secondaries. In case of an alternative arrangement, the Bidder shall bring out the details in the Bid.
- 7.12.5 The CVT secondary terminals shall brought out in to a weather proof terminal box for ease of access. The terminal box shall have an IP rating of not less than IP 55. The terminal box shall be provided with a removable gland plate at the bottom and shall be suitable for accepting the required number of PVC insulated PVC sheathed, 10 core 2.5 mm² standard copper conductor cable.
- 7.12.6 All terminals shall be clearly marked to facilitate connection of secondary wiring.
- 7.12.7 Secondary fuses or MCBs shall be provided on or adjacent to each CVT, located such that they are accessible while the primary is live and shall be provided with labels indicating their function and their phase colours CVT secondary circuits shall be complete in themselves and shall be earthed at one point only. A separate earth link shall be provided for each secondary winding and shall be situated at the CVT.
- 7.12.8 Where CVTs are supplied which are, or may be connected to different sections of the bus bar, it shall not be possible for the CVT secondary circuits, to be connected in parallel.
- 7.12.9 An auxiliary switch or relay shall be provided in each phase of the secondary circuit of the synchronizing and metering voltage supply connections to break the circuits automatically as soon as the circuit breaker is opened.
- 7.12.10 To prevent ferro resonance, suitable damping devices shall provided for connection to the transformer secondaries.
- 7.12.11 CVTs shall meet the requirements, given in this section of the specification.

- 7.12.12 The creepage and flashover distances of the high voltage insulator shall be suitable for the out door service conditions, specified in the schedules.
- 7.12.13 The bidder in the offer is to state the suitable precautions/methods, adopted during design stage of the CVT to avoid the un-desirable effects due to ferro resonance phenomena. The precautions/methods include lower level of working flux density in EMU, greater utilization of the linear portion of the magnetization curve, providing an air gap in the magnetic circuit, connecting a suitable damping resistance permanently across the secondary etc.
- 7.12.14 It should be stated in the bid offer regarding the steps taken in the design stage for elimination/minimization of the influence of the transient response on the behavior of high speed relays.
- 7.12.15 It shall be ensured by the bidder in the offer that the connection of carrier, frequency coupling device across the CVT will not affect the designated accuracy class of the CVT windings.
- 7.12.16 The capacitor divider unit shall comply to IS: 9348/1979.
- 7.12.17 It shall also be complied in the offer through a calculation sheet, proving that the designated accuracy class of the CVT (both metering and protection) are not affected by extreme temperatures, to be encountered in service conditions (Max. ambient temperature 50° C and minimum -0° C).
- 7.12.18 The terminal contractors should be suitable for ACSR MOOSE,/' ZEBRA'(as per requirement) Conductor, complying to Cl.No.A.7.18.8 of this specification.

8.. TESTS:-

- 8.1 Type Tests:- The offered 220KV, 132KV & 33KV Inductive voltage transformer &400KV,220kv, 132KV capacitive voltage transformer should have been subjected to the following type tests in a Government approved Test Laboratory. The bidder shall furnish four sets of type test reports along with the offer. These tests must not have been conducted earlier than five years from the date of opening of the bid. For any change in the design/type already type tested and to the design/type offered against this specification, the purchaser reserves the right to demand repetition of some or all type tests/special tests without any extra cost to OPTCL in the presence of purchaser's representative at the cost of the supplier.

For 220 KV, 132KV & 33KV IVT:

- (a) Temperature rise test.
- (b) Short circuit withstand capability test.
- (c) Lightning Impulse Test.
- (d) High Voltage power frequency wet withstand voltage tests.

- (e) Determination of errors.
- (f) IP-55 Test on secondary Terminal Box.

N.B:- [I] The dielectric type tests should have been carried out on the same transformer.

- (ii) After the IVT was subjected to the dielectric tests, it should have been subjected to all routine tests as per relevant standards.
- (iii) For Temperature Rise Test, the test must have been made with the appropriate rated burden, connected to each secondary winding.

For 400 kv, 220KV & 132KV CVT.

TYPE TESTS/SPECIAL TESTS FOR 400 KV, 220KV, 132KV CVT:-

- a) Lightning Impulse voltage test on complete CVT unit.
- b) Power frequency over-voltage test on complete CVT unit.
- c) Partial discharge test.
- d) Radio interference voltage test.
- e) Corona extinction voltage test.
- f) Temperature rise test on complete CVT unit.
- g) Ferro resonance test on the complete C.V.T. unit.
- h) Transient response tests.
- i) Determination of Temperature Co-efficient test.
- j) High frequency capacitance and equivalent resistance measurement test (as per IEC-358)
- k) Stray capacitance and stray conductance test (as per IEC-358).
- l) Accuracy tests.
- m) Thermal stability test.
- n) Thermal Co-efficient test (as per IEC-358)
- o) Fast transient test.
- p) Seismic withstand test.
- q) IP-55 test on secondary Terminal Box.
- r) Magnetization and internal burden tests.
- s) Effectiveness of sealing tests.
- t) Mechanical Terminal load test on Bushing.
- u) Dielectric loss angle test (Tan Delta Test).

N.B:- 1. The dielectric type tests should have been carried out on the same CVT.

2. After the CVT was subjected to the dielectric tests, it should have been subjected to all routine tests as per relevant standards.
3. The ratio errors, phase displacements before, during and after the temperature rise test on complete CVT unit should have been determined with stipulated burdens and the same should comply with the designated accuracy class for each winding of the CVT.

8.2 ROUTINE TESTS:- The following routine tests shall be conducted on each VT in the presence of Purchaser's representative for which no charges will be payable by OPTCL. No sampling is allowed.

- (a) Verification of terminal markings.
- (b) Power frequency withstand tests on primary windings/capacitor voltage divider for IVT/CVT
- (c) Partial discharge measurement for 400 KV, 220KV, 132KV IVT & 220KV & 132KV CVT.
- (d) Power frequency withstand tests on secondary windings/Low voltage terminal of the capacitor divider for 220KV & 132KV CVT.
- (e) Power frequency withstand tests between sections.
- (f) Determination of errors on complete IVT./CVT.
- (g) Measurement of Insulation resistance.
- (h) Oil leakage test.
- (i) Measurement of capacitance and dielectric dissipation factor before and after dielectric tests (as per IEC-358)
- (j) Power frequency tests on electromagnetic unit for 400 KV, 220KV & 132KV CVT.
- (k) Any other test as per relevant national & international standards.

N.B.:- Determination of errors shall be performed after the other tests. The standard reference VT to be used during testing for determination of ratio error and phase angle error should be of 0.05 accuracy class or better as per standard practice, presently adopted by OPTCL.

9. INSPECTION:

9.1 The Purchaser shall have access at all times to the works and all other places of manufacture, where the IVTs/CVTs are being manufactured and the supplier shall provide all facilities for unrestricted inspection of the supplier's works, raw materials, manufacturer of all the accessories and for conducting the necessary tests.

9.2 The Supplier shall keep the Purchaser informed in advance of the time of starting and of the progress of manufacture of equipment in its various stages so that arrangement could be made for inspection at the discretion of the Purchaser.

9.3 No material shall be despatched from its manufacture unless the material has been satisfactorily inspected, tested and despatch clearance issued. However, the Purchaser reserves the right to alter the despatch schedule attached to this Specification.

9.4 The acceptance of any quantity of equipment shall in no way relieve the supplier of his responsibility for meeting all the requirements of this Specification and shall not prevent subsequent rejection, if such equipments are found to be defective.

9.5 Clear 15 (Fifteen) days notice shall be given to this office for deputing officer(s) for inspection. The Voltage Transformers shall be despatched only after the inspection is conducted by a representative of OPTCL and release order, issued from this office after approval of Routine Test Certificates. The shop routine test certificates in triplicate for all the Voltage Transformers along with the calibration certificates of all the meters and equipments to be used during testing (as per Annexure-B of the Specification) should be furnished along with the Inspection Offer. The Inspecting Officer will be authorised for inspection of the Voltage Transformers subject to the condition that the routine test certificates and calibration certificates of the testing equipments/meters will be found to be in order.

10. QUALITY ASSURANCE PLAN:-

10.1 The Bidder shall invariably furnish following informations along with his offer.

[i] Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards, according to which the raw materials are tested, list of tests, normally carried out on raw materials in presence of Bidder's representative, copies of test certificates.

[ii] Information and copies of test certificates as in [i] above in respect of bought out items.

[iii] List of manufacturing facilities available.

[iv] Level of automation achieved and list of areas where manual processing exists.

[v] List of areas in manufacturing process where stage inspections are normally carried out for quality control and details of such tests and inspection.

[vi] Special features provided in the equipment to make it maintenance free.

[vii] List of testing equipments, meters and test plant limitation, if any, vis-à-vis the type, acceptance and routine tests, specified in the relevant standards. These limitations shall be very clearly brought out in the offer.

[viii] All the testing equipments, meters etc. should have been calibrated in a Government approved laboratory. The Bidder must submit the list of testing equipments and meters test-wise as per ANNEXURE-B of the Technical Specification.

10.2 The Supplier shall within 30 days of placement of order submit the following information to the Purchaser.

- [i] List of raw materials as well as bought out accessories and the names of the materials as well as bought out accessories and the name of Sub-suppliers selected from those, furnished along with the offer.
- [ii] Type test certificates of the raw materials and bought out accessories.
- [iii] Quality Assurance Plan (QAP) with hold points for the Purchaser's possible inspection. The QAP and hold points shall be discussed between the Purchaser and the Supplier before the QAP is finalised.

10.3 The Supplier shall submit the routine test certificates of bought out items and raw materials at the time of acceptance testing of the fully assembled equipment.

11 DOCUMENT: The supplier shall furnish four sets of following drawings/documents along with his offer.

- [a] General outline and assembly drawings of the Inductive Voltage Transformers/ Capacitive Voltage Transformers.
- [b] Sectional views showing:-
 - [i] General constructional features.
 - (ii) Materials/gaskets/sealing used.
 - iii] The insulation of the winding arrangements, method of connection of primary/secondary winding to the primary/secondary terminals etc.
- [c] Schematic drawing.
- [d] Rating & diagram plate as per relevant IEC/ISS
- [e] Secondary Terminal Box.
- [f] Assembly Sectional view of Primary terminal./ capacitor voltage divider
- [g] Assembly drawing for secondary terminal
- [h] The detailed dimensional drawing of Porcelain Housing such as ID,OD, thickness and insulator details such as height, profile of petticoats, angle of inclination and gap between successive petticoats, total creepage distance etc.
- [i] Sectional view of pressure release device.
- [j] Drawing showing details of Oil level.
- [k] All type test reports relating to the tests as specified in Clause-8.1 of the above.
- [l] Ratio and phase angle error curves for IVTS/ CVTS
- [m] Magnetization characteristic curves such as B-H curves and Sp. Loss vs. Flux density curves for core material, used for IVT & EMU unit of CVT.

[n] Sectional view of EMU unit of 400 KV,220KV&132KV CVT

12. TEST REPORTS:-

- [i] Four copies of type test/special test reports shall be furnished to the Purchaser with the tender offer.
 - [ii] Copies of acceptance test reports and routine test reports shall be furnished to the Purchaser. One copy will be returned, duly certified by the Purchaser and only thereafter shall the materials be despatched.
 - [iii] All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the Purchaser.
 - [iv] All test reports of tests, conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when required for by the purchaser.
13. The necessary galvanized flanges, bolts etc. for the base of the Inductive/Capcitive Voltage Transformers shall be supplied without any extra cost to the purchaser.

14. PACKING AND FORWARDING:-

14.1 The equipment shall be packed in suitable crates so as to withstand handling during transport and outdoor storage during transit. The supplier shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing. The easily damageable material shall be carefully packed and marked with the appropriate caution symbols. Wherever necessary, proper arrangement for lifting such as lifting hooks etc. shall be provided. Any material found short inside the packing cases shall be supplied by supplier without any extra cost.

14.2 Each consignment shall be accompanied by a detailed packing list containing the following informations:

- [a] Name of the consignee.
- [b] Details of consignment.
- [c] Designation.
- [d] Total weight of consignment.
- [e] Sign showing upper, lower side of the crate.
- [f] Handling and unpacking instructions.
- [g] Bill of materials indicating contents of each package.
- [h] Set of approved drawings.

14.3 The supplier shall ensure that the bill of materials is approved by the Purchaser before despatch.

15. Any tender without complete information as asked for in the above Specification is likely to be rejected.

CVT's shall be suitable for high frequency (HF) coupling required for power line carrier communication. The carrier signal must be prevented from flowing into potential transformer (EMU) circuit by means of a RF choke/reactor suitable for effectively blocking the carrier signals over the entire carrier frequency range i.e. 40 to 500 kHz. Details of the arrangement shall be furnished along with the bid. HF terminal of the CVT shall be brought out through a suitable bushing and shall be easily accessible for connection to the coupling devices of the carrier communication equipment, when utilised. The bushing shall be fully protected against rain and vermin so as to avoid the possibility of short circuits to earth. An earthing link with fastener shall be provided for HF terminal. The electromagnetic unit comprising compensating reactor, intermediate transformer and protective and damping devices should have a separate terminal box with all secondary terminals brought out. Voltage transformers should be thermally and dielectrically safe when the secondary terminals are loaded with the guaranteed thermal burdens. The accuracy of the metering winding (0.2) shall be maintained throughout the entire burden range up to 100 VA/100 VA/1100 VA for 420kV CVT's on all the three windings without any adjustments during operation.

Constructional features

420 KV CVT's shall be suitable for mounting on support structure of made out of preferably lattice or tubular GI pipe of nominal bore of 300/200 mm.

Access to secondary terminals shall be possible without any danger of access to high voltage circuit. Voltage transformers shall be hermetically sealed units.

A protective surge arrester/spark gap shall be provided to prevent breakdown of insulation by incoming surges and to limit abnormal rise of terminal voltage of shunt capacitor/primary winding, tuning reactor/RF choke etc. due to short circuit in transformer secondaries. In case of an alternate arrangement, Bidder shall bring out the details in the Bid.

The wiring diagram for the interconnection of the three single phase CVT's shall be provided inside the marshalling box in such a manner that it does not deteriorate with time. The wiring diagrams shall be fixed

The primary and secondary windings of voltage transformers shall be constructed from high purity, annealed, high conductivity copper meeting the requirements of IEC 28.

The VT secondary terminals shall be brought out into a weather proof terminal box for ease of access. The terminal box shall have an IP rating of not less than IP 55. The terminal box shall be provided with a removable gland plate at the bottom and shall be suitable for accepting the required number of PVC insulated PVC sheathed 10 core 2.5 mm² stranded copper conductor cable.

All terminals shall be clearly marked to facilitate connection of secondary wiring.

Secondary fuses or MCB's shall be provided on or adjacent to each voltage transformer, located such that they are accessible while the primary is live and shall be provided with labels indicating their function and their phase colours. Voltage transformer secondary circuits shall be complete in themselves and shall be earthed at one point only. A separate earth link shall be provided for each secondary winding and shall be situated at the voltage transformer.

Where voltage transformers are supplied which are, or may be, connected to different sections of the busbar, it shall not be possible for the voltage transformer secondary circuits to be connected in parallel.

An auxiliary switch or relay shall be provided in each phase of the secondary circuit of the synchronising and metering voltage supply connections to break the circuits automatically as soon as the circuit breaker is opened.

To prevent ferro resonance, suitable damping devices shall be provided for connection to the transformer secondaries.

Voltage transformers shall meet the requirements given in this section of the Specification.

The creep age and flash over distances of the high voltage insulator shall be suitable for the outdoor service conditions specified in the Schedules.

Oil Filled voltage transformers

The following facilities shall be provided for oil filled voltage transformers:

- Visual oil level indicator of prismatic or other or means of determining the position of the diaphragm or bellows seal visible from ground level.
- Oil drain cock and sampling valve where applicable.

Requirement Of 420kv Capacitor Voltage Transformer

Particulars	Parameters		
Rated primary	420kV		
Type	Single phase capacitor voltage transformer		
No. of secondaries	3		
Rated voltage factor	1.2 continuous 1.5 for 30 seconds		
Phase angle errors	±20 minutes		
Capacitance(pF)	4400/8800+10% ,-5%(as per applicable)		
Voltage Ratio $\frac{kV}{V}$	Secondary core Nos.		
	Core-1 $\frac{400/\sqrt{3}}{110/\sqrt{3}}$	Core-2 $\frac{400/\sqrt{3}}{110/\sqrt{3}}$	core-3 $\frac{400/\sqrt{3}}{110/\sqrt{3}}$
Application	Protection	Protection	Metering and instrumentation
Accuracy	3P	3P	0.2
Output burden(VA) minimum*	100	100	100

*The bidder shall also estimate the requirement of burden and offer the same as an alternative for the Employers consideration.

REMARKS :

C.T., P.T. & CVT consoles. Marshalling box shall be of aluminium alloy of 3mm are to be supplied along with the C.T., P.T. & CVT equipments. One console box is required for 3 nos. equipment. Details of quantities required are to be engineered by the contractor. These consoles are suitable for outdoor mounting and shall have proper slope at the top for easy discharge of water.

APPENDIX – I.

TECHNICAL REQUIREMENTS FOR 400 KV,220KV, 132KV & 33KV INDUCTIVE VOLTAGE TRANSFORMERS &400 KV,220KV, 132KV CAPACITIVE VOLTAGE TRANSFORMER.

Sl. No	Particulars.	Description.				
		400 KV/220KV CVT	220KV IVT	132KV CVT	132KV IVT	33KV IVT
1	Type	Single phase, 50Hz, oil Filled, self cooled, Hermetically sealed, Outdoor porcelain type.	Single phase, 50Hz, oil filled, self cooled, Hermetically sealed, outdoor porcelain type	Single phase, 50Hz, oil Filled, self cooled, Hermetically sealed, Outdoor porcelain type.	Single phase, 50Hz, oil filled, self cooled, Hermetically sealed, outdoor porcelain type.	Single phase,50Hz, oil filled, self cooled, Hermetically sealed, outdoor porcelain type.
2	Nominal system voltage.	400 KV/220KV	220KV	132KV	132KV.	33KV.
3	Highest system voltage.	420 KV/245KV	245KV	145KV	145KV.	36KV
4	Frequency.	50Hz± 5%	50Hz± 5%	50Hz ± 5%	50Hz± 5%	50Hz± 5%
5	System earthing.	Effectively solidly earthed.	Effectively solidly earthed.	Effectively solidly earthed.	Effectively solidly earthed	Effectively solidly earthed
6	Number of phases.	3 [single phase]	3 [single phase]	3 [single phase]	3 [single phase]	3 [single phase]
7	(i)Number of secondary windings. (ii)Purpose of windings.	3 [three] Protection & metering.	2 (two) Protection & metering	3 [three] Protection & metering.	2 [two] Protection & metering.	2 (two) one protection and one Metering)
8	Rated primary voltage.	400/1.732 KV / 220/1.732 KV	220/1.732 KV	132/1.732 KV	132/1.732KV	33/1.732KV
9	Rated secondary voltage.	Winding-I-110/1.732V Winding-II-110/1.732V Winding-III-110/1.732V	Winding-I-110V /1.732V (Protection) Winding-II-110/1.732V (Metering)	Winding-I-110/1.732V Winding-II-110/1.732V Winding-III-110/1.732V	Winding-I-110V/ 1.732V (Protection) Winding-II-110/ 1.732V(Metering)	110/1.732V (Metering) 110/1.732V Protection
10	Ratio	400 KV/1.732/110V/1.732 & 220KV/1.732/ 110V/1.732	220KV/1.732/ 110V /1.732V	132KV/1.732/ 110V/1.732	132KV/1.732/ 110V/1.732V	33KV/1.732/ 110/1.732
11	Rated burden.	Winding-I (P)-100VA Winding-II (P)-100VA Winding-III(M)-100VA/0.2 class & simultaneous burden- 100 VA with accu. cl-0.2	Winding-I(P)- 150VA /3P; Winding-II(M)- 150VA/0.2 class & simultaneous burden- 150VA with accu. cl-0.2	Winding-I (P)-100VA /3P; Winding-II (P)- 100VA/3P; Winding-III (M)- 75VA/0.2 class & simultaneous burden-100	Winding-I(P)- 150VA /3P; Winding-II(M)- 150 VA /0.2 & Simultaneous Burden- 150 VA with accu. cl-0.2	Winding-I(P)- 75VA /3P; Winding-II(M)- 75 VA /0.2 & Simultaneous Burden- 75 VA

				VA with accu. cl-0.2		
12	Accuracy class .	3P/3P/0.2	3P/ 0.2	3P/3P/0.2	3P/ 0.2	3P/0.2
13	Rated voltage factor at rated frequency.	1.2 continuous. 1.5 for 30 second.	1.2 continuous. 1.5 for30 seconds.	1.2 continuous. 1.5 for 30 second.	1.2 continuous. 1.5 for30 seconds.	1.2 continuous. 1.5 for 30 seconds
14	Temperature rise at 1.2 times the rated primary voltage, rated frequency & rated burdens.	As per IEC-186	As per IEC-186.	As per IEC-186	As per IEC-186.	As per IEC-186.
15	Temperature rise at 1.5 times the rated primary voltage for 30 seconds, rated frequency & rated burden.	As per IEC-186.	As per IEC-186.	As per IEC-186.	As per IEC-186.	As per IEC-186
16	One-minute power frequency dry withstands test voltage for primary winding.	630KV (rms)/ 460KV [rms]	460KV [rms]	275KV [rms]	275KV [rms]	70KV (rms)
17	1-minute power frequency wet withstands test voltage for primary winding.	630KV(rms)/460KV [rms]	460KV [rms]	275KV [rms]	275KV [rms]	70KV (rms)
18	1.2/50 micro second impulse withstand test voltage for primary winding	1425 KV(peak) /1050KV [peak]	1050KV [peak]	650KV [peak]	650KV [peak]	170KV (peak)
19 (i) (ii)	One-minute power frequency withstands test voltage for Secondary winding Between LV(HF) terminal & earth terminal	3KV [rnms] 10KV [rms] for exposed terminals & 4KV [rms] for terminals, enclosed in a weatherproof box.	3KV [rms]	3KV [rnms] 10KV [rms] for exposed terminals & 4KV [rms] for terminals, enclosed in a weatherproof box.	3KV [rms] -	3 KV (rms)
20	Class of insulation.	‘A’ or better for EMU.	‘A’	‘A’ or better for EMU.	‘A’	‘A’
21	Material of the conductor of primary and secondary windings.	Copper for EMU	Copper	Copper for EMU	Copper.	Copper
22	Fault level of the bus to which PTs will be connected.	40KA [rms].for 1 second.	40KA [rms].for 1 second.	31.5KA [rms]	31.5KA [rms].for 1second.	25KA for 1 second.
23	Minimum creepage distance.	10500mm /	6125mm	3625 mm	3625mm	900mm

24	Quality of oil.	EHV Grade As per IS-335.	EHV Grade As per IS-335.	EHV Grade As per IS-335.	EHV Grade As per IS-335.	EHV Grade As per IS-335.
25	Radio interference voltage at 1.1 times maximum rated voltage at 1.0 MHZ.	500 micro volts.	500 micro volts.	500 micro volts.	500 micro volts.	-
26	Partial discharge level.	Less than 10 piccoulombs.	Less than 10 piccoulombs.	Less than 10 Piccoulombs.	Less than 10 piccoulombs.	
27	Seismic acceleration- Horizontal – Vertical.	0.3g. 0.15g.	0.3g. 0.15g.	0.3g. 0.15g.	0.3g. 0.15g.	0.3g. 0.15g.
28	Accuracy class of standard V.T. to be used during testing towards determination of ratio errors and phase angle errors for metering windings.	0.05 or better.	0.05 or better.	0.05 or better.	0.05 or better.	0.05 or better.
29.	Capacitance (Pf)	4400/8800 (as applicable) + 10%,-5%	-	4400 + 10%,-5%	-	-

Name of the test.	Meters and equipments required for the corresponding test	Date of Calibration.	Due date of Calibration.	Name of the Calibrating Agency.	Whether Calibrating Agency is Govt. Approved.	Whether documents relating to Govt. Approval of the calibrating Agency furnished ?	Whether the meters/equipment fulfill the accuracy class as per calibration	Whether the calibrating agency has put any limitation towards the use of the particular	Whether green sticker or blue sticker or yellow sticker has been affixed on the body of the	Inspite of imposed limitations,, whether the particular meter/equipment can still be	Remarks
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	with range, accuracy, make and Sl. No.						report	meter/equipmen t. If yes, state the limitations.	particular equipment/met er. State the colour of the affixed sticker.	used ? Justify its use for corresponding test(s).	
1	2	3	4	5	6	7	8	9	10	11	12

Signature of the tenderer with seal and date.

ANNEXURE-C

CHECK LIST TOWARDS TYPE TEST REPORTS.

Name of the Type Test.	Date of Test.	Name of the Laboratory where the Test has been conducted.	Whether the Laboratory is Government Approved.	Whether the Test reports are valid as per Clause No.8.1 of T.S.	Whether the copy of Test Report in complete shape alongwith drawings etc. furnished or not ?	Whether the Tested I.V.T/CVT fulfills the technical requirements as per TS.	If the type tested I.V.T/CVT does not fulfill the technical requirements as per this specification, whether the bidder agrees to conduct the particular test(s) again at their own cost without any financial liability to OPTCL in	Re mark

							the presence of OPTCL's representative within the specified delivery period.	
1	2	3	4	5	6	7	8	9

Signature of the Tenderer with seal and date.