

SECTION-
INSTRUMENT TRANSFORMERS

TECHNICAL SPECIFICATIONS

CHAPTER-INSTRUMENT TRANSFORMERS

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Section - Instrument Transformers

CHAPTER –INSTRUMENT TRANSFORMERS

1.0 GENERAL

- 1.1 Qualifying Requirements Please refer Bid documents.
- 1.2 The instrument transformers shall conform to the latest version of the standards specified below except to the extent explicitly modified in the specification and shall be in accordance with IEC : 61869 and IS : 2705 for current transformer and IEC : 61869 and IS : 3156 for Inductive voltage transformers & capacitive voltage transformers.
- 1.3 The instrument transformers shall be complete with its terminal box and a common marshalling box for a set of 3 instrument transformers.
- 1.4 The instrument transformer tank along with top metallic shall be hot dip galvanized.
- 1.5 The impregnation details along with tests/checks to ensure successful completion of impregnation cycle shall be furnished for approval.
- 1.6 Bellows if used for expansions of transformer oil shall be tested in accordance with relevant standards. The details of the same to be furnished for approval.

2.0 CONSTRUCTION FEATURES:

The features and constructional details of instrument transformer shall be in accordance with requirements stipulated hereunder:

- 2.1 Bushings/ Insulators:
 - a). Instrument transformers shall be of 220kV, 110kV, 66KV Class, oil filled, with shedded porcelain bushings/ Insulators suitable for outdoor service and upright mounting on steel structures.
 - b). The Bushing/ insulator for CT shall be one piece without any metallic flange joint.
- 2.1.1 Bushings shall be manufactured and tested in accordance with IS:2099 & IEC: 60137. While hollow column insulators shall be manufactured and tested in accordance with IEC 60233/IS:5621. The support insulators shall be manufactured and tested as per IS-254-4./IEC 60168 and IEC 60273. The insulators shall also conform to IEC 60815 as applicable.

- 2.1.2 The Bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from land nations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.
- 2.1.3 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.
- 2.1.4 Bushings/ hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions Under which they will be used.
- 2.1.5 When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators/bushing when operating at the normal rated voltage.
- 2.1.6 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.
- 2.1.7 All iron parts shall be hot dip galvanized and all joints shall be airtight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by matching. Insulators/bushing design shall be such as to ensure a uniform compressive pressure on the joints.
- 2.1.8 Tests:

In accordance with the requirements stipulated under Clause No.13.0 of this Section bushing/hollow column insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS : 2009 & IS : 2544 and IS 5601.

2.1.9 Technical parameters of bushing/hollow column insulator:

Sl. No	Particulars	For 245 KV system	For 123kV system	For 72.5 KV system	For 12.1 KV system
1	Rated volatage (KV)	245	123kV	72.5	36
2	Impulse withstand	±1050	550	±325	±170

3	Switching surge with stand voltage (dry and wet) (KVP)	-	-	-	-
4	Power frequency withstand voltage (dry and wet)KV rms	450	230	140	70
5	Total creepage distance (mm)	6125	3075	1813	900
6	Pollution class-iii heavy (as per IEC 71) and as specified in section-2 for all class of equipment.	-	3075	-	-
7	Insulator shall also meet requirement of relevant standards for 245KV, 110 KV, 66 KV & 33KV system, as applicable having alternate long & short sheds	-	-	-	-

- c). Bushing shall be provided with oil filling and drain plugs, oil sight glass for CT, IVT and electromagnetic unit for CVT etc. The bushing/ insulator of instrument transformer shall have a cantilever strength of not less than 350 Kg for 245KV, 110KV and 66KV Instrument transformers.
- d) Instrument transformers shall be hermetically- sealed units. Bidder/ Manufacturer shall furnish details of the arrangements made for the sealing of instrument transformers along with the bid. Bidder/ Manufacturer shall not furnish the details, tests to check the effectiveness of hermetic sealing.
- e). Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.

2.2 **Terminal box / Marshalling box:**

2.3 The Marshalling Box shall generally conform to and be tested in accordance with IS : 5039 / IS : 8623, IEC-439, as applicable, and the clauses given below:

2.4 Marshalling boxes & terminal boxes shall be made of sheet steel or aluminum enclosure and shall be dust, water and vermin proof. Sheet steel used shall be at least 2.0 mm thick cold rolled or 2.5 mm hot rolled. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. In case of aluminum enclosed box the

thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.

- 2.5 The enclosures of the terminal boxes & marshalling boxes shall provide a degree of protection of not less than (IP:53). After protection degree test of marshalling kiosk, 2.5 KV rms for 1(one) minute, insulation resistance and functional test should have been conducted. In case these tests have not been carried out during IP : 55 test, then the contractor shall carry out the IP-55 test along with these tests, at his cost.
- 2.6 Cabinet/boxes shall be free standing floor mounting type, wall mounting type or pedestal mounting type as per requirements.
- 2.7 Terminal boxes/Marshalling boxes shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere. The quality of the gasket shall be such that it does not get damaged/cracked during the operation of the equipment.
- 2.8 All doors removable covers and plates shall be gasketed all around with suitably profiled **Neoprene** gaskets. The gasket shall be tested in accordance with approved quality plan. The quality of gasket shall be such that it does not get damaged/ cracked during the ten years of operation of the equipment or its major overhaul whichever is earlier. All gasket surfaces shall be smooth, straight and reinforced if necessary to minimize distortion and to make a tight seal. Ventilating louvers, if provided, shall have screen and fillers. The screen shall be fine wire mesh made of brass.
- 2.9 The terminal boxes/Marshalling Box shall be designed for the entry of cables from bottom by means of weather proof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet.

Suitable cable gland plate projecting at least 150mm above the base of the marshalling kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland plate. The gland shall project at least 25mm above gland plate to prevent entry of moisture in cable crutch. Gland plate shall have provision for some future glands to be provided later, if required. The Nickel-plated glands shall be dust proof; screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS: 6121.

- 2.10 A 240V, single phase, 50Hz, 15 amp AC plug and socket shall be provided in the cabinet with ON-OFF switch for connection of hand lamps. Plug and socket

shall be of industrial grade.

2.11 For illumination of Marshalling Box a 15 Watts CFL shall be provided.

2.12 All control switches shall be of rotary switch type and Toggle/piano switches shall not be accepted.

2.13 **Earthing**

Positive earthing of the cabinet shall be ensured by providing two separate earthing pads. The earth wire shall be terminated on to the earthing pad and secured by the use of star of self-etching washer. Earthing of hinged door shall be done by using a separate earth wire.

2.14 **Tests**

a) The marshalling kiosks shall be subject to routine tests as per IS:5039.

b) The following routine tests shall also be conducted.

i) Check for wiring

ii) Visual and dimension check

Marshalling kiosks shall be provided with danger plate and a diagram showing the numbering/ connection/ ferruling by pasting the same on the inside of the door.

2.15 **TERMINAL BLOCKS AND WIRING**

2.16 Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All inter-phase and external connections to equipment or to control cubicles will be made through terminal blocks.

2.17 Terminal blocks shall be 1100V grade and have continuous rating to carry the maximum expected current on the terminals. Those shall be of moulded piece, complete with insulated barriers stud type terminals, washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. But preferably the terminal blocks shall be non-disconnecting stud type equivalent to Elmex type, CATM4, Phoenix cage clamp type of Wage or equivalent. The insulating material of terminal block shall be Nylon 6.6, which shall be free of halogens, fluorocarbons etc.

- 2.18 Terminal blocks for current transformers and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short-circuiting and earthing facilities.
- 2.19 The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.
- 2.20 The conducting part in contact with cable shall preferably be tinned or silver plated however Nickel plated copper or zinc plated steel shall also be acceptable.
- 2.21 The terminal blocks shall be of extendable design.
- 2.22 The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.
- 2.23 The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.
- 2.24 Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.
- a) All circuits except : Minimum of two of 2.5 Sq. mm CT circuits copper flexible.
 - b) All CT circuits : Minimum of 4 Nos. of 6 Sq. mm copper flexible
- 2.25 The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinets is live.
- 2.26 At least 20% spare terminals shall be provided on each panel/ cubicle/ box and these spare terminals shall be uniformly distributed on all terminal rows.
- 2.27 There shall be minimum clearance of 250mm between the First/bottom row of terminal block and the associated cable gland plate. Also the clearance between two rows of terminal blocks shall be minimum of 150mm.
- 2.28 The Contractor shall furnish all wire, conduits and terminals for the necessary interphase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets.

- 2.29 All input and output, terminals of each control cubicle shall be tested for surge withstand capability in accordance with the relevant IEC Publications, in both longitudinal and transverse modes. The Contractor shall also provide all necessary filtering, surge protection, interface relays and any other measures necessary to achieve an impulse withstand level at the cable interfaces of the equipment.

2.3 **Insulating Oil :**

Insulating oil to be used for instrument transformers shall conform to IS: 335/IEC: 60296, (required for first filling)

2.4 **Name Plate:**

Name plate shall conform to the requirements of IEC incorporating the year of manufacture. The rated current, extended current rating in case of current transformers and rated voltage, voltage factor in case of voltage transformers shall be clearly indicated on the nameplate. The rated thermal current in case of CT shall also be marked on the nameplate.

The intermediate voltage in case of capacitor voltage transformer shall be indicated on the name plate.

3.0 **CURRENT TRANSFORMERS:**

- a) Current transformers shall be of dead tank type having single primary either ring type or hair pin type **or Live tank with Bar primary / ring type** and suitably designed for bringing out the secondary terminals in a weather proof (IP 55) terminal box at the bottom.

These secondary terminals shall be terminated to stud type non disconnecting terminal blocks inside the terminals box.

- b) Different ratios specified shall be achieved by secondary taps only without primary reconnection.
- c) Core lamination shall be of cold rolled grain oriented silicon steel or other equivalent alloys. The cores used for protection shall produce undistorted secondary current under transient conditions at all ratios, with specified CT parameters.
- d) The expansion chamber at the top of the porcelain insulators should be suitable for expansion of oil.
- e) Facilities shall be provided at terminal blocks in the marshalling box for star delta formation, short circuiting and grounding of CT secondary terminals.

- f) Current transformer's guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.
- g) For 245KV, 123KV and 72.5KV class CTs the rated extended primary current shall be 120% on all cores of the CTs specified in Section - 1.
- h) For 245KV, 123KV and 72.5KV Current transformer, characteristics shall be such as to provide satisfactory performance of burdens ranging from 25% to 100% of rated burden over a range of 10% to 100% of rated current in case of metering CTs and up to the accuracy limit factor/ knee point voltage in case of protection cores of CTs used for relay circuits.
- i) The current transformers shall be suitable for horizontal transportation. It shall be ensured that the CT is able to withstand all the stresses imposed on it while transporting and there shall be no damage in transit. The Contractor shall submit the details of packing design to the Owner for review.
- j) For 245KV, 123KV and 72.5KV CTs the instrument security factor at all ratios shall be less than five (5) for metering core. If any auxiliary CTs / reactors are used in the current transformers then all parameters specified shall have to be met treating auxiliary CTs as an integral part of the current transformer. The auxiliary CTs / reactors shall preferably be in built construction of the CTs.
- k) The wiring diagram plate for the interconnection of the three single phase CTs shall be provided inside the marshalling box.
- l) The current transformers should be suitable for mounting on lattice support structure to be provided by the Contractor in accordance with stipulations of Clause 25.0 of Section - 2 (GTR) and Clause 7. 1. 1 of Section - 7.0 (Structure).
- m) The CT shall be designed as to achieve the minimum risks of explosion in service. Bidder/ Manufacturer shall bring out in his offer the measures taken to achieve this.
- n) 245KV current transformers shall be suitable for high speed auto re-closing.
- o) The current transformer shall have a single core with wound primary. Super enameled wire shall preferably be used for secondary windings. COPPER CONDUCTOR shall be used for all windings.

4.0 **CAPACITOR VOLTAGE TRANSFORMERS FOR 220KV:**

- a) 245KV Voltage transformers on line side shall be capacitor voltage divider type with electromagnetic units and shall be suitable for carrier coupling.
- b) Voltage transformers secondary shall be protected by HRC cartridge type fuses for all the windings. In addition fuses shall be provided for the protection and

metering windings for fuse monitoring scheme. The secondary terminals of the CVT shall be terminated to the stud type non-disconnecting terminal blocks in the individual phase secondary boxes via the fuses.

- c) CVTs shall be suitable for high frequency (HF) coupling required for power line carrier communication. 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 500KHz. Details of the arrangement shall be furnished along with the bid. HF terminal of CVT shall be brought out through a suitable bushing and shall be easily accessible for connection to the coupling filters of the carrier communication equipment, when utilized. Further, earthing link with fastener to be provided for HP terminal
- d) The electromagnetic unit comprising compensating reactor, intermediate transformer and protective and damping devices should have separate terminal box with all the secondary terminals brought out.
- e) The damping device which should be permanently connected to one of the secondary windings, should be capable of suppressing the Ferro resonance oscillations.
- f) The CVT is required for protection and communication purposes only and not for metering purposes.
- g) 245KV CVT shall be suitable for mounting on support structure in accordance with KPTCL specification.
- h) It should be ensured that access to secondary terminals is without any danger of access to high voltage circuit
- i) A protective Surge Arrester 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.
- j) The wiring diagram for the interconnection of the three single phase CVTs shall be provided inside the marshalling box in such a manner that it does not deteriorate with time.

5.0 **TERMINAL CONNECTORS:**

The terminal connectors shall meet the requirements as per IS: 5561 and KPTCL specification.

6.0 **TYPE TESTS :**

- 6.1 The current and voltage transformers should have been type tested as per IEC/IS and shall be subjected to routine tests in accordance with **IEC 61869-1 & 2/ IS : 2705 & IEC 61869-1,3 & 5/ IS : 3156** respectively

Type tested current and voltage transformers shall be offered. The type test reports shall not be older than Fifteen (15) years for 66kV and above voltage level, Five (5) for below 66kV Voltage level on the day of bid opening.

a) For current and voltage transformers manufactured in India:

- i. The type tests on indigenous equipment for which testing facility is available in India, should have been conducted in any independent laboratories approved by the Government or the laboratories accredited by the National accreditation body of the country like Central Power Research Institute (CPRI), Electrical Research and Development Association (ERDA), etc.
- ii. The type tests on indigenous equipment, for which testing facility is not available in India, should have been conducted in a laboratory of foreign country accredited by National accreditation body of that country.
- iii. The type tests conducted in-house by a manufacturer shall also be acceptable provided the laboratory is accredited by National accreditation body of the country and the tests has been conducted in the presence of a representative of NABL accredited laboratory or any of the purchasing utilities or CEA in that order. Such type test reports shall record the details of such witness including the signature/authentication in the type test report.

b) For current and voltage transformers manufactured Abroad:

- i. Type tests on imported equipment should have been conducted in an Indian Laboratory or foreign laboratory accredited by National accreditation body of the country where the Type test has been conducted.
- ii. The type tests conducted in-house by a manufacturer shall also be acceptable provided the laboratory is accredited by National accreditation body of the country and the tests has been conducted in the presence of a representative of accredited laboratory or any of the purchasing utilities or CEA in that order. Such type test reports shall record the details of such witness including the signature/authentication in the type test report.

In case of in-house type tested imported equipment of foreign OEM, the term “Purchasing Utility” covers the foreign Utility who has purchased that equipment

6.2 For 245KV / 123K V / 72.5KV CTs, CVTs and VTs following additional type tests are also proposed to be conducted in addition to the other type tests as per IS & IEC in the relevant schedule.

a) For Current Transformers:

- 1) Radio interference test - As per IS: 8263
- 2) Thermal stability test i.e., application of rated voltage and rated current simultaneously by synthetic test circuit.
- 3) Thermal co-efficient test i.e. measurement of tan delta as a function of temperature (at ambient and between 80° and 90°C) and voltage (at 0.3, 0.7, 1.0 and 1.1 $U_m/3$)

b) For CVTs:

1. High Frequency capacitance & equivalent series resistance measurement as per IEC 60358
2. Seismic withstand test (as per Annexure -A)
3. Stray capacitance & stray conductance measurement of the low voltage terminal as per IEC 60358
4. Determination of temperature co-efficient test as per IEC 60358
5. Transmitted Overvoltage test
6. Mechanical tests
7. Determination of the temperature coefficient (T_c)
8. Tightness design test of capacitor units

c) For CTs & IVTs:

1. Seismic withstand test (As per Annex - A)
2. Chopped impulse voltage withstand test on Primary terminals
3. Multiple chopped impulse test on primary terminals
4. Measurement of capacitance & di-electric dissipation factor
5. Transmitted Overvoltage test
6. Mechanical tests

6.3 ROUTINE TESTS

The current and voltage transformers shall be subjected to the following routine/ site tests in addition to routine tests as per IEC/ IS.

a) Current Transformers:

Routine Tests :

- 1) Measurement of Capacitance

- 2) High voltage power frequency withstand test on Secondary Winding
- 3) Over voltage inter turn test.
- 4) Oil leakage test
- 5) Measurement of tan delta at 0.3, 0.7, 1.0 and 1.1 $\mu\text{m}/3$
- 6) Measurement of partial discharge as per IEC 61869

Site Test :

Dissolved gas analysis to be carried out at the time of commissioning. CTs must have adequate provision for taking oil samples from the bottom of the CT without exposure to atmosphere. Bidder/ Manufacturer shall recommend the frequency at which oil samples should be taken and norms for various gases in oil after being in operation for different durations. Bidder/ Manufacturer should also indicate the total quantity of oil which can be withdrawn from CT for gas analysis before refilling or further treatment of CT becomes necessary.

b) CAPACITIVE - Voltage transformers

- 1) Capacitance and loss angle measurement before and after voltage test - as per IEC: 60358
- 2) Partial discharge test on capacitor dividers - as per IEC: 60358,
- 3) Sealing Test - as per IEC - 60358
- 4) Natural frequency of capacitors unit determination (Resonant frequency of capacitor units)

7.0 SPARE PARTS

The bidder shall include in his proposal spare parts in accordance with Section - I & 2.

8.0 PARAMETERS :

- 1) 245/ 123 / 72. 5kV Current Transformers

	220KV	110KV	66KV
Rated primary current	As per Requirement	As per Requirement	As per Requirement

Quantities			
Rated short time thermal current for 1sec	50kA	40kA	40kA
Rated dynamic current (kAp)	100	100	100
Maximum temperature rise over design ambient temperature	As per IEC / IS	As per IEC / IS	As per IEC / IS

Note: Please refer APPENDIX-3 Technical particulars for Current Transformers.

8.1 B) 245KV CAPACITIVE - VOLTAGE TRANSFORMERS :

- a) Quantity As per requirement
- b) System fault level 50kA for 1 Sec
- c) Standard reference range of Frequencies which the accuracies are valid 97% to 103% for protection and 99% to 10 1% for measurement.
- d) High frequency capacitance Within 80% to 150% of rated capacitance
- e) Equivalent series resistance over the entire carrier frequency range less than 40 ohms
- f) Stray capacitance and stray conductance of the LV terminal over entire frequency range As per IEC : 358
- g) One minute power frequency withstand voltage
 - i) Between LV(HF) Terminal and earth terminal 10KV (rms) for exposed terminals and 4KV (rms) for terminals enclosed in a weather proof box
 - ii) For secondary winding As per IEC
- h) Maximum temperature rise over design ambient temperature As per IEC

- i) Number of terminals in control Cabinet
All terminals of control circuits are wired up to marshalling box plus 20% spare terminals, evenly distributed on all TBs.

- j) Rate total thermal burden(VA) 400

Capacitive Voltage Transformers shall also comply with the requirements of Table 1B & 1C of this chapter.

9.0 TESTING & COMMISSIONING:

- 9.1 An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P/ Instructions of the equipment Supplier or Owner without any extra cost to the Owner. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Owner for approval.

9.2 Current Transformer

- a) Insulation Resistance Test for primary and secondary
- b) Polarity test
- c) Ratio identification test - checking of all ratios on all cores by primary current injection method.
- d) Dielectric test of oil (wherever applicable)
- e) Magnetizing characteristics test.
- f) Tan delta and capacitance measurement
- g) Secondary winding resistance measurement

9.3 Capacitive Voltage Transformers

- a) Insulation Resistance test for primary and secondary winding.
- b) Polarity test.
- c) Ratio test
- d) Dielectric test of oil (wherever applicable)

e) Tan delta and capacitance measurement between

HV - HF point

HF point - Ground point of Intermediate Transformer

HV - Ground point of Intermediate Transformer primary winding.

f) Secondary winding resistance measurement.

10.00 TECHNICAL SPECIFICATION FOR VOLTAGE TRANSFORMERS :

10.01 SCOPE :

10.01.01 This specification provides for design, manufacturer, inspection and testing before dispatch, packing and delivery FOR (Destination), testing and commissioning of electro magnetic type outdoor voltage transformers along with all accessories specified herein for protection and metering services. The voltage class of VTs required are 220kV, 110kV, 66kV and 33kV.

10.01.02 Following is the list of documents constituting this specification:

- i) Technical specification
- ii) Technical Data sheets

10.01.03 The voltage transformers, shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer and owner shall have the power to reject any work on material, which in his judgment is not in full accordance therewith.

10.02 STANDARDS:

10.02.01 Unless otherwise specified elsewhere in this specification, the voltage transformers shall conform to the latest revisions and amendments there of the following standards:

Sl No	Standard No	Title
1.	IEC: 61869	Instrument Transformer
2	IER : 1956	
3	IS : 5	Colours for paint and enamels
4	IEC : 44(4)	Voltage transformers-measurement of PDs
5	IEC : 60	High voltage testing techniques
6	IS : 104	Ready mixed paints and brushing
7	UEC : 171	Insulation coordination
8	IEC : 60296	Partial discharge measurement

9	IS:335/IEC: 60296	Insulating oil for transformers
10	IS : 649	Methods of testing of steel sheets for magnetic circuits and power electrical apparatus
11	IS : 2071(Part I to III)	Method of high voltage testing
12	IS : 2099	High voltage porcelain brushings
13	IS : 2147	Degree of protection provided by enclosures for low voltages, switchgear and control
14	IS : 2165	Insulation coordination for equipment of 110 KV and above
15	IS : 2927	Brazing alloys
16	IS : 3156	Voltage transformers
17	IS : 3024	Electrical steel sheets (oriented)
18	IS : 3134	Guide for selection of insulators in respect of polluted conditions
19	IS : 3347	Dimensions for porcelain for transformer brushings electrical power connectors
19	IS : 5561	Electric Power connector
20	IS : 5621	Hollow insulators for use in electrical equipments
21	IS : 6792	Determination of electrical strength of insulating coils
22	IEC : 8263	Method of RIV test on high voltage insulators

10.02.02 Equipment meeting with the requirements of other authoritative International Standards, which ensure equal or better performance than 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. Two copies of such standards with authentic translation in English shall be furnished along with the offer.

10.03 **PRINCIPAL PARAMETERS:**

The Voltage Transformers covered in this specification shall meet the technical requirements listed here under:

Sl. No	Item	245 KV	123 KV	72.5 KV	36 KV
1	Type / Installation	Single phase oil filled hermetically sealed outdoor type			
2	Type of mounting	----- Pedestal Type -----			

3	Highest system frequency	245	123	72.5	36
4	Suitable for system frequency	----- 50 Hz -----			
5	Voltage Ratio:				
	i) Rated primary voltage (kV)	220/ $\sqrt{3}$	110 / $\sqrt{3}$	66 / $\sqrt{3}$	33 / $\sqrt{3}$
	ii) Secondary voltage (volts)	----- 110 / $\sqrt{3}$ -----			
6	Method of earthing the system where the VT will be installed	----- Effectively earthed ----- (Solidly grounded)			
7	1.2 / 50 micro second lightning impulse withstand voltage (KVP)	1050	550	325	170
8	1 minute dry power frequency withstand voltage primary (KV rms)	460	230	140	70
9	Minimum creepage distance of porcelain housing (mm)	6125	3075	1813	900
10	Rated voltage factor	---- 1.5 for 30 seconds --- 1.2 continuous			
11	1 minute power frequency withstand voltage				
	i) Low voltage terminal (HF) and earth terminal (KV rms)	4 if the low voltage is exposed to weather			
	ii) Withstand voltage for secondary winding (KV rms)	----- 2 -----			
12	Max temperature rise over ambient of 50 deg C	---- As per IEC 86 ----			
13	Rated total thermal burden	300 VA	--- 300 VA ----		
		200 VA	---- 200 VA ---		
		200VA	---- 50 VA ---		
14	No. of terminals in control cabinet	All contacts and control circuits to be wired up to control cabinet plus 20 % extra terminals exclusively for owner's use.			
15	Siesmic accelaration (Horizontal)	----- 0.3 g -----			
16	Standard reference voltage for which accuracies are valid	97% to 103% for protection 99% to 101% for metering			

10.04 COREWISE DETAILS OF VOLTAGE TRANSFORMERS

Sl. No.	PARTICULARS	REQUIREMENTS			
1	Rated primary voltage	245 KV	123 KV	72.5 KV	36 KV
2	Type	220KV / $\sqrt{3}$	110KV / $\sqrt{3}$	66KV / $\sqrt{3}$	33KV / $\sqrt{3}$
3	No. of Secondaries	Three	Three		
4		----- 1.2 continuous ----- ----- 1.5 for 30 seconds -----			
5	Phase angle error	----- + / - 20 minutes -----			
6	Rated voltage (volts)	CORE – I 110V / $\sqrt{3}$	CORE – I 110V / $\sqrt{3}$	CORE – I 110V / $\sqrt{3}$	CORE – I 110V / $\sqrt{3}$
		CORE – II 110V / $\sqrt{3}$	CORE – II 110V / $\sqrt{3}$	CORE – II 110V / $\sqrt{3}$	CORE – II 110V / $\sqrt{3}$
		CORE-III 110V/ $\sqrt{3}$	CORE– III 110V / $\sqrt{3}$	CORE– III 110V/ $\sqrt{3}$	CORE– III 110V / $\sqrt{3}$
7	Application	Metering	Metering	Metering	Metering
		Protection	Protection Open Delta	Protection Open Delta	Protection Open Delta
		Protection	Protection	Protection	Protection
8	Accuracy	0.2 3P 3P	0.2 3P 3P	0.2 3P 3P	0.2 3P 3P
9	Output Burden	300VA 200 VA 200VA	300VA 200VA 50VA	300VA 200VA 50VA	300VA 200VA 50VA

10.05 DEFINITIONS AND TERMINOLOGY:

In accordance with Clause 3.0 and sub-clauses there of as per IS : 3156 (part I to III) – 1998.

10.06 SERVICE CONDITIONS:

This shall be in accordance with Clause 4.0 and sub-clauses thereof as per IS : 3156 (Part – I) – 1998 except for the Clauses 4.4 , 4.5 (a), 4.5 (b) 4.5(c) (ii). However, the voltage transformers shall be suitable for tropical conditions and for atmospheres conducive to the growth of fungi and condensation of moisture. The VTs shall be suitable for installation in a solidly grounded system.

8.07 INSTALLATION REQUIREMENTS, TYPE AND CONSTRUCTION :

8.08 GENERAL :

- 10.08.01 The VTs shall be suitable for outdoor installation and for upright mounting on steel structures. The necessary flanges, bolts, etc., for the base of VT shall be supplied and these shall be galvanized.
- 10.08.02 They shall be of the oil immersed, self-cooled type and provided alternatively with an inert gas cushion or with metallic bellows above the insulating oil level. A pressure relief device valve type may also be provided if permitted in the design. The base shall be provided with suitable welded M.S. Channels for bolting the VT in an upright position to the VT mounting structure.

10.09 DESIGN :

The VTs may be built up of high-grade non ageing cold rolled grain oriented silicon steel lamination, conforming to IS : 3024 of low hysteresis losses and high permeability to ensure high accuracy at both normal rated and above rated voltages. The laminations shall be coated on both sides with suitable insulation capable of withstanding stress relieve annealing. The cores shall meet with the requirements of the accuracy class, corresponding to the voltage factors in respect of the composite limits of accuracy as applicable for each type of core namely metering and protection.

10.10 INSULATING OIL

The oil shall be mineral insulating oil conforming to IS : 335/IEC: 60296.

10.11 LIMITS OF TEMPERATURE RISE:

This shall be with reference to an ambient temperature of 45° C at specified rated frequency and at rated burden or at the highest rated burden connected to the secondary windings. The limits of temperatures rise shall not exceed the values specified in Table 3 of IS : 3156 (Part-1) 1998. However, if the voltage transformers has an inert gas cushion above the oil at the top of the tank or housing shall not exceed 50° C.

10.12 WINDING:

10.12.01 Primary Winding:

Primaries of Potential Transformers will be connected in phase to Neutral and the neutral point is solidly earthed. The primary winding shall be of copper.

10.12.02 Secondary Winding:

Potential Transformers shall be provided with three secondary windings each rated for 63.5 Volts. Core-I will be used for metering and core II & III for protection and relaying. The secondary winding shall be of copper.

10.12.03 Normally no joints in the winding shall be allowed. Joints unavoidable shall be brazed with high silver alloy grade of IS: 2927 or but welded.

10.13 **BUSHING:**

This shall be as per Clause 4.1 of IS : 3156 (Part-1)-1992. A plastic sight gauge glass shall be provided on the top of the bushing metal assembly. The minimum creepage length of the bushing insulator/ hollow insulator shall be as follows:

245 kV	6125 mm
123kV	3075 mm
72.5 kV	1813 mm
36 kV	900 mm

10.14 **EARTHING:**

Refer Earth mat specification.

10.15 **TERMINAL ARRANGEMENT:**

10.15.01 Primary:

The primary bushing terminals shall be of the rigid type suitable for connection to an ACSR conductor through terminal connectors. The terminal shall be of tin plated copper, the connector shall be a bimetallic connector conforming to IS : 5561-1970 and shall be as per Clause 7.00 infra specified herein.

The HV neutral end terminal shall not be earthed directly to the metal body of the VT but shall be brought out through a porcelain 2 KV class bushing. Similarly an earth bushing, shall also be provided for connecting to the owner's GI flat earth riser. A tinned copper link of the bolted type shall be provided to connect the HV neutral end terminal and the earth bushing. Both the HV neutral end bushing and the earth bushing shall be housed in a dust tight, vermin proof box with a front access bolted type gasketed cover. This housing shall be on the opposite face of the secondary terminal box.

10.15.02 Secondary :

The secondary terminals of the VT shall be housed in a dust tight, vermin proof box and with a front access gasketed cover. The terminal box shall be of mild steel of thickness 3 mm. The terminals shall be made of brass and of the front projection stud type. The stud shall be provided with a locking checknut and other checknuts for securing the crimped terminals of external VT secondary cables. The bottom of the box shall be provided with nickel-plated cable glands to receive and support 3R x 4C x 6 sq mm PT secondary cables. The number of glands shall be equivalent to the number of secondary cores.

10.15.03 V.T. Marshalling Box:

A weather proof, vermin proof, outdoor type separately mounted marshalling box shall also be supplied and installed for each of the three phases, at the rate of one number for each set of 3 nos. of phase connected VTs. The marshalling box shall be of such size so as to accommodate three sets of vertically mounted terminal blocks. The secondary leads from each phase and core are to be connected to these terminal blocks for forming star or delta connection. The terminal blocks shall be of the cast resin moulded type capable of withstanding 2 KV for 1 (one) minute. The terminals shall be of the front projection brass stud and nut type provided with locking checkouts and with hexagonal nuts, flat spring washers for securing the crimped conductor lugs of external cables. Insulated cast resin barriers shall also be provided in between the different terminals in the terminal block. Each terminal block shall contain 9 (nine) numbers of terminals. The box shall be provided with a front access gasketed cover and an earthing stud. The cover shall be of the bolted type. The earthing stud shall be provided with brass locking checknuts both on the inside and outside and with brass nuts, flat and spring washers. The bottom plate of the box shall be provided with 3 (three) Nos. of cable glands suitable to receive 12R x 4Cx 6 sq mm VT secondary control cables. The terminals shall preferably be shrouded with transparent plastic covers.

The top of the box shall be provided with 3 (three) Nos. of 25 mm circular dummy plates for fixing PVC/G 1 pipes for leading in the secondary lead wires or cables from the VT secondary terminals of each individual VT. The kiosk shall be painted both on the inside and outside with two coats of grey enameled paint as per Clause 8.00 infra specified herein.

11.00 **PRIMARY TERMINAL CONECTOR:**

11.01 The connection shall be a rigid bimetallic connector suitable for receiving ACSR conductor as follows

245 KV DRAKE ACSR of all diameter 28.14 mm/63mm Al. tube

123 KV DRAKE ACSR of overall diameter 28.14mm/63mm Al. tube

72.5 KV DRAKE ACSR of overall diameter 28.14mm /50mm Al. tube

36 KV COYOTE ACSR of overall diameter 15.86mm

11.02 The connector shall conform in all respects to Clauses (4),(5),(6),(7),(8) and sub-clauses thereof as per IS : 5561-1970. The connector shall also be etched with the name of the ACSR conductor, which it shall receive.

11.03 The rating of the connector shall be as follows

Rated current 400Amps

Rated frequency 50 Hz

Rated short time current 50KA for 245 KV
40 KA for 123 & 72.5 KV,
25kA for 36 KV

12.00 PAINTING:

All metal surfaces in contact with insulating oil shall be painted with heat resistant paint insoluble to oil and insulating varnish. The pre-painting procedure shall consist of sand blasting, de-rusting, phosphating and priming of both the exterior and interiors in accordance with IS : 6005.

13.00 MARKING

Every VT shall have the markings conforming to Clause 7.0 and sub clauses thereof as per IS : 3156 (Part - I) and (Part -II) - 19992 and clause 9.0 and sub - clauses thereof as per IS : 3156 (Part – III) - 1992.

14.00 **TESTS:** All the type tests, additional type tests, routine tests, site tests shall be done as per clause 6.0 specification above

15.00 Inspection

A representative of the owner shall have free access at all times to inspect the manufacturer's work and to witness the tests.

16.00 Table 1B:

Sl No	Particulars	
1	Rated primary	245

	voltage		
2	Type	Single phase capacitor VT	
3	No. of secondaries	2	
4	Rated voltage factor	1.2	
5	Phase angle error	20 minutes(for metering)	
6	Capacitance (pF)	8800/4400 (As Applicable) +10%, -5%	
		Secondary-1	Secondary-2
7	Voltage ratio	$220\text{kV}/\sqrt{3} / 110\text{V}/\sqrt{3}$	$220\text{kV}/\sqrt{3} / 110\text{V}/\sqrt{3}$
8	Application	Protection	Protection
9	Accuracy	3P	3P
10	Output burden(VA) (minimum)	150	150

Table 1C:

S1 No	Particulars			
1	Rated primary voltage	245		
2	Type	Single phase capacitor VT		
3	No. of secondaries	3		
4	Rated voltage factor	1.2		
5	Phase angle error	20 minutes(for metering)		
6	Capacitance (pF)	8800/4400 (As Applicable) +10%, -5%		
		Secondary-1	Secondary-2	Secondary-3
7	Voltage ratio	$220\text{kV}/\sqrt{3} / 110\text{V}/\sqrt{3}$	$220\text{kV}/\sqrt{3} / 110\text{V}/\sqrt{3}$	$220\text{kV}/\sqrt{3} / 110\text{V}/\sqrt{3}$
8	Application	Protection	Protection	Metering
9	Accuracy	3P	3P	0.2
10	Output burden(VA) (minimum)	150	150	150

ANNEXURE-

A

SEISMIC WITHSTAND TEST PROCEDURE

The seismic withstanding test on the complete equipment (except Power Transformer) shall be carried out along with supporting structure.

The Bidder shall arrange to transport the structure from his Supplier's premises/KPTCL sites for the purpose of seismic withstand test only.

The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the Terminal Pad of the equipment and any other point as agreed by the Owner. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the Owner.

APPENDIX-3
Technical Parameters of Current Transformers (Type & Rating)

Sl No	Technical Particulars	Type-1	Type-1a	Type-1b	Type-1c	Type-1d	Type-2	Type-2a	Type-2b	Type-2c	Type-2d	Type-3	Type-3a	Type-3b	Type-3c	Type-3d	Type-3e	Type-3f	Type-3g	Type-4
1	Normal System Voltage (KV)	220KV	220KV	220kV	220kV	220kV	110KV	110KV	110KV	110KV	110KV	66KV	66KV	66KV	66KV	66KV	66kV	66kV	66KV	33KV
2	Highest System Voltage (KV)	245KV	245KV	245kV	245kV	245kV	123KV	123KV	123KV	123KV	123KV	72.5KV	72.5KV	72.5KV	72.5KV	72.5KV	72.5kV	72.5kV	72.5KV	36KV
3	Frequency	50Hz	50Hz	50Hz	50Hz	50Hz	50Hz	50Hz	50Hz	50Hz	50Hz	50Hz	50Hz	50Hz	50Hz	50Hz	50Hz	50Hz	50Hz	50Hz
4	Earthing	Effective	Effective	Effective	Effective	Effective	Effective	Effective	Effective	Effective	Effective	Effective	Effective	Effective	Effective	Effective	Effective	Effective	Effective	Effective
5	Basic Insulation Level (KV Peak)	1050	1050	1050	1050	1050	650	650	650	650	650	325	325	325	325	325	325	325	325	170
6	Power Frequency withstand strength (KV RMS)	460	460	460	460	460	275	275	275	275	275	140	140	140	140	140	140	140	140	70
7	Short Time Current rating (KA for 1 sec)	50	50	50	50	50	40	40	40	40	40	40	40	40	40	40	40	40	40	31.5
8.	Secondary winding current rating (Amp)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9	Number of cores	5	5	5	5	5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
10	Ratio	800-600-400-300/1-1-1A with two extra cores of ratio 800/1A	1200-800-400-300/1-1-1A with two extra cores of ratio 1200/1 A	1600-1200/1-1-1A with two extra cores of ration 1600/1 A	2000-1600-1200/1-1-1A with two extra cores of ration 1200/1 A	1600-800/1-1-1-1-1A	600-400/1-1-1A	400-200/1-1-1A	200-100/1-1-1A	1000-600/1-1-1A	800-400/1-1-1A	1000-600/1-1-1A	400-200/1-1-1A	200-100/1-1-1A	1600-1000/1-1-1A	800-400/1-1-1A	1000-800/1-1-1A	1200-800/1-1-1A	400-200-100/1-1-1A	400-200/1-1-1A
11	Purpose for which used	220KV line & 220kV Transformer	220KV line with 1000Sq. mm cable & 220kV Transformer	220kV line with 1200/2000 Sq.mm XLPE UG cable	220kV Bus Coupler& Sectionalizer	220kV line with Twin Zebra conductor	220 kV 110kV 100MVA transformer & 110KV bus coupler	110KV lines with Lynx conductors	110KV Transformers	220 kV 110kV 160MV A transformer & 110KV bus coupler	220 kV 110kV 160MV A transformer & 110KV bus coupler	220 kV 100MV A Tr. & 66KV Bus Coupler	66KV line using lynx / coyote & 31.5MV A Tr. & 66KV capacitor bank	Up to 20MVA Tr.	220 kV – 150MV A Tr.	66KV lines using Drake & 630 Sq. mm cable	66kV line with 1000 Sq.mm XLPE, UG cable	66kV line with 1000 Sq.mm XLPE, UG cable	66KV line using lynx / coyote & 31.5MV A, 20MVA, 12.5MV A Tr. & 66KV capacitor bank	Transformer protection

12	Method of obtaining Secondary ratio	By secondary tapping without primary reconnection	By secondary tapping without primary reconnection	By secondary tapping without primary reconnection.	By secondary tapping without primary reconnection.	By secondary tapping without primary reconnection.	By secondary tapping without primary reconnection	By secondary tapping without primary reconnection	By secondary tapping without primary reconnection	By secondary tapping without primary reconnection	By secondary tapping without primary reconnection	By secondary tapping without primary reconnection	By secondary tapping without primary reconnection	By secondary tapping without primary reconnection	By secondary tapping without primary reconnection	By secondary tapping without primary reconnection	By secondary tapping without primary reconnection	By secondary tapping without primary reconnection	By secondary tapping without primary reconnection	By secondary tapping without primary reconnection
13	Suitability of Bimetallic terminal connector	Drake ACSR (28.14 mm Dia) or 63mm Aluminium Tube	Drake ACSR (28.14 mm Dia) or 63mm Aluminium Tube	Double Moose ACSR or 63mm Aluminium tube	Double Moose ACSR or 63/75/100mm Aluminium tube	Double Moose ACSR or 63/75/100mm Aluminium tube	Drake ACSR (28.14mm Dia or 63mm Aluminium Tube)	Drake ACSR (28.14 mm Dia or 50mm Aluminium Tube)	Drake ACSR (28.14 mm Dia or 50mm Aluminium Tube)	Drake ACSR (28.14 mm Dia or 50mm Aluminium Tube)	Drake ACSR (28.14 mm Dia or 50mm Aluminium Tube)	Twin Drake ACSR (28.14 mm Dia or 50mm Aluminium Tube)	Drake ACSR (28.14 mm Dia or 50mm Aluminium Tube)	Drake ACSR (28.14mm Dia or 50mm Aluminium Tube)	Twin Drake ACSR (28.14 mm Dia or 50mm Aluminium Tube)	Drake ACSR (28.14mm Dia or 50mm Aluminium Tube)	Twin drake ACSR or 50mm Aluminium tube	Twin drake ACSR or 50mm Aluminium tube	Drake ACSR (28.14 mm Dia or 50mm Aluminium Tube)	Drake ACSR (28.14 mm Dia or 50mm Aluminium Tube)

Sl. No	Type of CT's	Purpose	Rated burden	Accuracy Class	Accuracy limit factor	Instrument security factor	Knee point volts (min) VK	Secondary winding resistance max. at 75°C RCT	Magnetizing current
A	220KV CT Type-1 Core-1	Distance/Transformer Differential	--	PS	--	--	1600V at 800/1A	5 Ohms at 800/1A 1.875 Ohms at 300/1A	30mA at Vk/4
	Core-2	Distance/Transformer Backup Protection	--	PS	--	--	600V at 300/1A	5 Ohms at 800/1A 1.875 Ohms at 300/1A	30mA at Vk/4
	Core-3	Metering	10VA	0.2S	--	≤ 5 at all ratios	1600V at 800/1A 600V at 300/1A	--	--
	Core-4	Bus Bar differential	--	PS	--	--	--	5 Ohm at 800/1A	30mA at Vk/4
	Core-5	Bus Bar differential	--	PS	--	--	1600V at 800/1A 1600V at 800/1A	5 Ohm at 800/1A	30mA at Vk/4

B(i)	220KV Type-1a	CT	Distance/Transformer Differential	--	PS	--	--	1200V at 1200/1A 400V at 300/1A	12 Ohms at 1200/1A 3 Ohms at 300/1A	30mA at V _k /4
	Core-2		Distance/Transformer Backup Protection	--	PS	--	--	1200V at 1200/1A 400V at 300/A	12 Ohms at 1200/1A 3 Ohms at 300/1A	30mA at V _k /4
	Core-3		Metering	10VA	0.2S	--	≤ 5 at all ratios	--		--
	Core-4		Bus Bar differential	--	PS	--	--	1200V at 1200/1A	--	
	Core-5		Bus Bar differential	--	PS	--	--	1200V at 1200/1A	12 Ohm at 1200/1A 12 Ohm at 1200/1A	30mA at V _k /4 30mA at V _k /4
B(ii)	220kV Type -1b	CT								
	Core-1		Distance/Differential	–	PS	–	–	1200V at 1200/1A	12 Ohms at 1200/1A	30mA at V _k /4
	Core-2		Distance/Transformer Backup protection	–	PS	–	–	1200V at 1200/1A	12 Ohms at 1200/1A	30mA at V _k /4

	Core-3	Metering	10VA	0.2S	–	≤5 at all ratios	–	–	–
	Core-4	Bus-Bar differential	–	PS	–	–	1600V at 1600/1A		30mA at V _k /4
	Core-5	Bus-Bar differential	–	PS	–	–	1600V at 1600/1A		30mA at V _k /4
B(ii)	220kV CT Type -1c								
	Core-1	Distance/Differential	–	PS	–	–	1200V at 1200/1A	12 Ohms at 1200/1A	30mA at V _k /4
	Core-2	Distance/Transformer Backup protection	–	PS	–	–	1200V at 1200/1A	12 Ohms at 1200/1A	30mA at V _k /4
	Core-3	Metering	10VA	0.2S	–	≤5 at all ratios	–	–	–
	Core-4	Bus-Bar differential	–	PS	–	–	1200V at 1200/1A		30mA at V _k /4
	Core-5	Bus-Bar differential	–	PS	–	–	1200V at 1200/1A		30mA at V _k /4
B(ii)	220kV CT Type -1d								
	Core-1	Distance/Differential	–	PS	–	–	1600V at 1600/1A 800V at 800/1A	8 Ohms at 1600/1A 4 Ohms at 800/1A	30mA at V _k /4

	Core-2	Distance/Transformer Backup protection	–	PS	–	–	1600V at 1600/1A 800V at 800/1A	8 Ohms at 1600/1A 4 Ohms at 800/1A	30mA at V _k /4 at
	Core-3	Metering	10VA	0.2S	–	≤5 at all ratios	–	–	–
	Core-4	Bus-Bar differential	–	PS	–	–	1600V at 1600/1A 800V at 800/1A	8 Ohms at 1600/1A 4 Ohms at 800/1A	30mA at V _k /4 at
	Core-5	Bus-Bar differential	–	PS	–	–	1600V at 1600/1A 800V at 800/1A	8 Ohms at 1600/1A 4 Ohms at 800/1A	30mA at V _k /4 at
C	110KV CT Type-2 Core –1	Differential Scheme	--	PS	--	--	1100V at 600/1A	5 Ohm at 600/1A	30mA at V _k /4 at
	Core –2	Metering	10VA	0.2S	--	≤ 5 at all ratios	--	--	--
	Core –3	Backup protection	30VA	5P	20	--	--	--	--
D	110KV CT Type –2a Core –1	Distance/ Differential Scheme	--	PS	--	--	800V at 400/1A	4 Ohm at 400/1A	30mA at V _k /4 at
	Core –2	Metering	10VA	0.2S	--	≤ 5 at all ratios	--	--	--
	Core –3	Backup protection	30VA	5P	20	--	--	--	--

E	110KV Type –2b Core –1	CT	Distance/ Differential Scheme	--	PS	--	--	400V at 200/1A	2 Ohm at 200/1A	30mA at Vk/4
	Core –2		Metering	10VA	0.2S	--	≤ 5 at all ratios	--	--	--
	Core –3		Backup protection	30VA	5P	20	--	--	--	--
F	110KV Type-2c Core –1	CT	Differential Scheme	--	PS	--	- -	1200V at 1000/1A	6 Ohm at 1000/1A	30mA at Vk/4
	Core –2		Metering	10VA	0.2S	--	≤ 5 at all ratios	--	--	--
	Core –3		Back up protection	30VA	5P	20	--	--	--	--
G	110KV Type-2d Core –1	CT	Distance/ Differential Scheme	--	PS	--	--	1400V at 800/1A	5 Ohm at 800/1A	30mA at Vk/4
	Core –2		Metering	10VA	0.2S	--	≤ 5 at all ratios	--	--	--
	Core –3		Back up protection	30VA	5P	20	--	--	--	--
H	66KV Type-3 Core –1	CT	Differential Scheme	--	PS	--	- -	1200V at 1000/1A	6 Ohm at 1000/1A	30mA at Vk/4
	Core –2		Metering	10VA	0.2S	--	≤ 5 at all ratios	--	--	--
	Core –3		Back up protection	30VA	5P	20	--	--	--	--
I	66KV CT Type-3a Core –1		Differential Scheme	--	PS	--	- -	1600V at 400/1A	4 Ohm at 400/1A	30mA at Vk/4

	Core -2	Metering	10VA	0.2S	--	≤ 5 at all ratios	800V at 200/1A	2 Ohm at 200/1A	30mA at Vk/4
	Core -3	Back up protection	30VA	5P	20	--	--	--	--
J	66KV CT Type-3b Core -1	Differential Scheme	--	PS	--	-	800V at 200/1A	2 Ohm at 200/1A	30mA at Vk/4
	Core -2	Metering	10VA	0.2S	--	≤ 5 at all ratios	--	--	--
	Core -3	Back up protection	30VA	5P	20	--	--	--	--
K	66KV CT Type-3c Core -1	Differential Scheme	--	PS	--	--	1200V at 1000/1A	6 Ohm at 1000/1A	30mA at Vk/4
	Core -2	Metering	10VA	0.2S	--	≤ 5 at all ratios	--	--	--
	Core -3	Back up protection	30VA	5P	20	--	--	--	--
L	66KV CT Type-3d Core -1	Distance/ Differential Scheme	--	PS	--	--	1400V at 800/1A	5 Ohm at 800/1A	30mA at Vk/4
	Core -2	Metering	10VA	0.2S	--	≤ 5 at all ratios	--	--	--
	Core -3	Back up protection	30VA	5P	20	--	--	--	--
M	66KV CT								

	Type-3e Core –1	Differential	–	PS	--	–	1200V at 1000/1A	6 Ohms at 1000/1A	30mA at V _k /4
	Core –2	Metering	10 VA	0.2S	–	≤5 at all ratios	–	--	--
	Core-3	Back-up protection	30VA	5P	20	–	–	–	–
N	66KV CT Type-3f Core –1	Differential	–	PS	--	–	2100V at 1200/1A 1400V at 800/1A	7.5 Ohms at 1200/1A	30mA at V _k /4
	Core –2	Metering	10 VA	0.2S	–	≤5 at all ratios	–	--	--
	Core-3	Back-up protection	30VA	5P	20	–	–	–	–
O	66KV CT Type-3g Core –1	Differential Scheme	--	PS	--	- -	1200V at 400/1A 600V at 200/1A 300V at 100/1A	4 Ohm at 400/1A 2 Ohm at 200/1A 2 Ohm at 200/1A	30mA at V _k /4
	Core –2	Metering	10VA	0.2S	20	≤ 5 at all ratios	--	--	--
	Core –3	Back up protection	30VA	5P		--	--		--
P	33KV CT Type-4 Core –1	Differential Scheme	--	PS	--	-	240V at 400/1A	5 Ohm at 400/1A	30mA at V _k /4

	Core –2	Metering	10VA	0.2S	--	≤ 5 at all ratios	--	--	--
	Core –3	Back up protection	30VA	5P	20	--	--	--	--
Q	33KV CT Type-4a	Metering	10VA	0.2S	--	≤ 5 at all ratios	--	--	--
	Core –1								
	Core –2	Protection	30 VA	5P	20	--	--	--	--