

Standard Specification
for
Instrument Transformers (CT & VT)

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1.0 GENERAL

- 1.1 The instrument transformers and accessories 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 the requirements in RFP.

Current Transformers (CT): IEC 61869-1 & 61869-2.

Capacitive Voltage Transformers (CVT): IEC 61869-1, 61869-5 & IEC 60358.

Inductive Voltage Transformers (IVT): IEC 61869-1, 61869-3.

- 1.2 The instrument transformers shall be complete with its terminal box and a common marshalling box for a set of three (3) instrument transformers.
- 1.3 The instrument transformers shall be designed for use in geographic and meteorological conditions as given in Section-GTR and Section-Project.

2.0 CONSTRUCTION FEATURES

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

- a) Instrument transformers of 800kV/420kV/245kV/145kV/72.5 kV class, shall be oil filled/SF6 gas filled, suitable for outdoor service and upright mounting on steel structures. **245kV, 420kV and 800kV CT shall be with polymer insulator.**
- b) Bushings/Insulators shall conform to requirements stipulated in relevant IS/IEC standards. The bushing/insulator for CT shall be one piece without any metallic flange joint.
- c) Oil filling & drain plugs and oil sight glass shall be provided for CT & IVT and oil sight glass shall be provided for electromagnetic unit of CVT. **The Instrument transformer shall have cantilever strength of not less than 500 kg, 350 kg and 250 kg respectively for 800/420kV, 245/145kV and 72.5kV Instrument transformers.** For CVT/IVT with polymer housing, the cantilever strength shall not be less than 150kg. Oil filling and drain plugs are not required for SF6 gas filled CT/IVT.
- d) Instruments transformers shall be hermetically sealed units. The details of the arrangements made for the sealing of instrument transformers shall be furnished during detailed engineering.
- e) Polarity marks shall indelibly be marked on each instrument transformer and at the lead terminals at the associated terminal block.
- f) SF6 filled CT/IVT shall be provided with a suitable SF6 gas density monitoring device, with NO/NC contacts to facilitate the remote annunciation and tripping in case of SF6 leakage. Provisions shall be made for online gas filling. A suitable rupture disc shall be provided to prevent explosion.
- g) The external surface of instrument transformer, if made of steel, shall be hot dip galvanized or painted as per Section-GTR. External surface of aluminum can have natural finish.

- h) The impregnation details alongwith tests/checks to ensure successful completion of impregnation cycle shall be furnished for approval.

2.1 Terminal Box / Marshalling Box:

Terminal box/Marshalling box shall conform to the requirements of Section-GTR.

2.2 Insulating Oil:

- a) The insulating oil to be used for instrument transformers shall be of EHV grade and shall conform to IS-335 / IEC 60296 (required for first filling). Non-PCB based synthetic insulating oil conforming to IEC 60867 shall also be used in the capacitor units of CVT.
- b) The SF6 gas shall comply with IEC 60376 and shall be suitable in all respects for use in the switchgear under operating conditions.

2.3 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 & intermediate voltage in case of voltage transformers shall be clearly indicated on the name plate.

3.0 CURRENT TRANSFORMER

- 3.1 Current transformers shall have single primary either ring type or hair pin type and suitably designed for bringing out the secondary terminals in a weatherproof (**IP-55**) terminal box at the bottom. PF (Tan delta) terminal for measurement of tan delta and capacitance of the unit shall be provided. These secondary terminals shall be terminated to **stud type non-disconnecting terminal blocks** inside the terminal box.

In case inverted type (Live Tank) current transformers, the manufacturer shall meet following additional requirements:

- a) The primary conductor shall be preferable be of bar type meeting desired characteristics.
 - b) The secondaries shall be totally encased in metallic shielding providing a uniform equipotential surface for even electric field distribution.
 - c) The lowest part of the insulation assembly shall be properly secured to avoid any risk of damage due to transportation stresses.
 - d) The upper part of insulation assembly resting on primary bar shall be properly secured to avoid any damage during transportation due to relative movement between insulation assembly & top dome.
 - e) Bellow made of stainless steel shall be used at the top of hermetic sealing of CT.
 - f) Bidder/Manufacturer shall recommend whether any special storage facility is required for spare CT.
- 3.2 Different ratios specified shall be achieved by secondary taps only and primary reconnection shall not be accepted.
 - 3.3 Core lamination shall be of cold rolled grain-oriented silicon steel or other equivalent alloys. μ metal or Nano-crystalline core can also be used for metering cores.

- 3.4 The expansion chamber at the top of the porcelain insulators should be suitable for expansion of oil.
- 3.5 Facilities shall be provided at terminal blocks in the marshalling box for star delta formation, short circuiting and grounding of CT secondary terminals.
- 3.6 Current transformer's guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.
- 3.7 The rated extended currents for 800 kV and 420 kV class Current transformers shall be as given below:

Tap Ratio	800KV, 3000A	400KV, 3000A
	Rated extended currents in % of rated current	
500/1	200	200
1000/1	---	---
2000/1	180	180
3000/1	120 (200 for 15 min)	120

The secondary winding shall be rated for 2A continuously.

Further, the intermediate tapping at 3000-2000 of metering core of 3000A rated 400kV and 800kV CTs shall be suitable for use as 1000/1 ratio. The auxiliary reactor, if used, shall be suitable for connecting to the selected taps.

For 245/145/72.5kV class CTs, the rated extended primary current shall be 120% (or 150% if applicable) on all cores of the CTs.

- 3.8 For 800/420/245/145/72.5kV 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 5% to 120% (or specified rated extended current whichever is higher) of rated current in case of metering CTs and up to the accuracy limit factor/knee point voltage in case of relaying CTs.
- 3.9 The current transformer 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 and transportation design to the Employer for review.
- 3.10 **For 800kV CTs, the instrument security factor at all ratios shall be less than ten (10) for metering core. For 420/245/145kV CTs the instrument security factor at all ratios shall be less than five (5) for metering core.** If any auxiliary CTs/reactor are used in the current transformers, then all parameters specified shall have to be met treating auxiliary CTs/reactor as an integral part of the current transformer. The auxiliary CTs/reactor shall preferably be inbuilt construction of the CTs. In case these are to be mounted separately, these shall be mounted in the central marshalling box suitably wired up to the terminal blocks.
- 3.11 The wiring diagram plate for the interconnections of the three-single phase CTs shall be provided inside the marshalling box.
- 3.12 800/420/245/145kV CTs shall be suitable for mounting on tubular pipe/ Lattice structure in accordance with relevant IS/IEC standards.
- 3.13 The CT shall be so 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.

- 3.14 800/420/245/145 kV current transformers shall be suitable for high-speed auto reclosing.

4.0 VOLTAGE TRANSFORMER

- 4.1 800/420/245/145 kV Voltage transformers shall be capacitor voltage divider type with electromagnetic units and shall be suitable for carrier coupling.
- 4.2 Voltage transformers secondary shall be protected by HRC cartridge type fuses or MCBs for all the windings. In addition, fuses/MCBs shall be provided for the protection and metering windings for fuse monitoring scheme. The secondary terminals of the VTs shall be terminated to the **stud type non-disconnecting terminal blocks** in the individual phase secondary boxes via the fuse/MCBs.
- 4.3 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 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 during detailed engineering. H.F. terminal of the 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 HF terminal.
- 4.4 The electromagnetic unit comprising compensating reactor, intermediate transformer and protective and damping devices should have separate terminal boxes with all the secondary terminals brought out.
- 4.5 The damping device, which should be permanently connected to one of the secondary windings, should be capable of suppressing the ferro-resonance oscillations.
- 4.6 The accuracy of 0.2 on metering core all CVTs/IVTs should be maintained throughout the entire burden range up to 50 VA on all the windings without any adjustments during operation.
- 4.7 800/420/245/145kV CVTs/IVTs shall be suitable for mounting on tubular pipe/ Lattice structure in accordance with relevant IS/IEC standards.
- 4.8 It should be ensured that access to secondary terminals is without any danger of access to high voltage circuits.
- 4.9 A protective surge arrester shall be provided if required, 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, the bidder shall bring out the details in the bid.
- 4.10 The wiring diagram for the interconnection of the three single phase CVTs/IVTs 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 Section-GTR and relevant IS/IEC standards.

6.0 TESTS

- 6.1 In accordance with requirement in Section-GTR, Current and Voltage Transformers should have been type tested and shall be subjected to routine tests in accordance with relevant IEC.
- 6.2 The test reports of the type tests as applicable as per IEC 61869-2 for CT, IEC 61869-5/IEC 60358 for CVT, and IEC 61869-3 for IVT and the following additional tests shall also be submitted for the Employer's review.

6.2.1 Current Transformers:

- i. **Multiple chopped impulse test on primary terminals** (not applicable for SF6 filled CT) to assess the CT performance in service to withstand the high frequency over voltage generated due to closing & opening operation of isolators. The method as per IEC 61869-1 and 2 may be followed with the application of 600 chopped impulses (for 145 kV & above rating only).
- ii. **Mechanical test** with minimum Cantilever load as per clause no. 2.0. (for 145 kV & above voltage class).
- iii. **Enclosure tightness test at low & high temperature** for SF6 filled CT (for 145 kV & above voltage class).
- iv. **Corrosion test** (for 145 kV & above voltage class)
- v. **Thermal stability test**, i.e. application of rated voltage and rated extended thermal current simultaneously by synthetic test circuit for 145kV and above voltage class (not applicable for SF6 filled CT).
- vi. **Thermal co-efficient test** i.e. measurement of tan delta as a function of temperature (at ambient and between 80°C & 90°C) and voltage (at 0.3, 0.7, 1.0 and 1.1 $U_m/\sqrt{3}$) for 145kV and above voltage class (not applicable for SF6 filled CT).
- vii. **Corona Extinction Voltage test** as per Section-GTR (for 420 kV & above voltage class).
- viii. **Radio interference voltage test** as per 61869 or Section-GTR (for 145 kV & above voltage class). However, RIV level shall be as specified at Annexure of this specification.
- ix. **Seismic withstand test** as per Section-GTR or IEC 62271-2 for 400kV and above voltage class.

6.2.2 Capacitive Voltage Transformers (CVT):

- i. **Mechanical test** with minimum Cantilever load as per clause no. 2.0.c (for 145 kV & above voltage class).
- ii. **Corrosion test** (for 145kV and above voltage rating)
- iii. **Determination of temperature coefficient test** as per IEC 61869- 1 and 5 (for 145kV & above voltage class).
- iv. **Tightness design test on capacitor unit** (for 145kV & above voltage class).
- v. **High frequency capacitance and equivalent series resistance measurement** (as per IEC 60358).

- vi. **Measurement of Stray capacitance and stray conductance of the low voltage terminal** (as per IEC 60358).
 - vii. **Corona Extinction Voltage test** as per Section-GTR (for 420 kV & above voltage class).
 - viii. **Radio interference voltage test** as per 61869 or Section-GTR (for 145 kV & above voltage class). However, RIV level shall be as specified at Annexure of this specification.
 - ix. **Seismic withstand test** as per Section-GTR or IEC 62271-2 for 400kV and above voltage class.
- 6.3 The current and voltage transformer shall be subjected to the following routine tests in addition to routine tests as per IEC.

6.3.1 CURRENT TRANSFORMERS:

For Oil filled CTs:

- a. Measurement of Capacitance.
- b. Oil leakage test.
- c. Measurement of Tan delta at 0.3, 0.7, 1.0 and 1.1 Um/ $\sqrt{3}$.

For SF6 filled CTs:

- a. Dew point measurement
- b. SF6 alarm/ lockout check.
- c. SF6 gas leakage test: Gas leakage rate shall be maintained within 0.2% per annum.

6.3.2 VOLTAGE TRANSFORMERS:

Routine tests on CVT/IVT shall be done in line with as per IEC 61869-3 and 5.

7.0 PRE-COMMISSIONING TESTS

- 7.1 An indicative list of tests is given below. For pre-commissioning procedures and formats for Instrument Transformer, Employer's Standard pre-commissioning document will be the reference document and shall be provided during detailed engineering.

Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment Supplier or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates at his own cost.

7.2 Current Transformers

- a. Insulation Resistance Test for primary and secondary.
- b. Tan delta and capacitance measurement
- c. Polarity test
- d. Ratio test - checking of all ratios on all cores.
- e. Magnetizing characteristics test.
- f. Secondary winding resistance measurement
- g. Contact resistance measurement (wherever possible/accessible).
- h. Test for SF6 (for SF6 filled CTs) – Dew point measurement, SF6 alarm/ lockout check.

- i. Dielectric test of oil (wherever applicable).
- j. DGA test of oil.

Dissolved gas analysis to be carried out twice within first year of service, first within first month of commissioning/charging and second between six months to one year from date of commissioning/charging. 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.

7.3 Voltage Transformers/Capacitive Voltage Transformers

- a. Insulation Resistance test for primary (if applicable) and secondary winding.
- b. Tan delta and capacitance measurement of individual capacitor stacks.
- c. Polarity test
- d. Ratio test
- e. Secondary winding resistance measurement
- f. Dielectric test of oil (wherever applicable).

Dissolved gas analysis shall be carried out twice within first year of service, first within first month of commissioning/charging and second between six months to one year from date of commissioning/charging. IVTs/PTs must have adequate provision for taking oil samples from the bottom of the IVT/PT 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 IVT/PT for gas analysis before refilling or further treatment of IVT/PT becomes necessary.

8.0 DEFECT LIABILITY

The actions required to be taken by the contractor in case of defects observed in CT/CVT/IVT of ratings 145kV & above during the warranty period (defect liability period) shall be as per following. Further, the replaced/repaired/ refurbished equipment (or part of equipment) shall have warranty without prejudice to contractual warranty period (defect liability period).

Equipment	Nature of problem	Corrective measures to be taken by contractor
CT/IVT/PT (oil filled)	DGA violation H ₂ > 300ppm C ₂ H ₂ > 2ppm	Refurbished or replaced
CT/IVT/PT (SF ₆ filled)	a. SF ₆ Gas leakage b. High dew point of SF ₆ (>-36°C at atmospheric pressure)	a. Repair/replacement. b. Re-processing of gas and replacement of gas in case of no improvement
CT/IVT/PT (oil filled)	Violation of Tan Delta >0.5% (during pre-commissioning) >0.7% (in operation)	Replacement
CT, CVT, IVT/PT	Oil leakage Low oil level Secondary winding problem leading to open/short circuit, saturation etc.	Replacement or repair as per approved repair procedure
CVT	Secondary voltage drift more than $\pm 0.5V$	Replacement

9.0 TECHNICAL PARAMETERS

9.1 MAJOR TECHNICAL PARAMETERS FOR CT

S. No.	Description	765kV system	400kV system	220kV system	132 kV system	66 kV System (for Tertiary loading)
1	Rated voltage, U _m (kV _{rms})	800	420	245	145	72.5
2	Rated frequency (Hz)	50				
3	No. of Poles	1				
4	Design ambient temperature (°C)	50				
5	Rated Primary Current (A)	3000	3000	3000/1600	1200/800/600	50
6	Rated extended primary current	120%	120%	120%	120%	120%
7	Rated short time thermal withstand current	50kA for 1 sec	63kA for 1 sec	50kA for 1 sec	40kA for 1sec	25kA for 3s
8	Rated dynamic current	125kAp	157.5kAp	125kAp	100kAp	63kAp
9	Temperature rise over design ambient temperature	As per IEC				
10	Rated Insulation levels					
a)	Full wave impulse withstand voltage (1.2/50 microsecond)					
i)	between line terminals and ground(kV _{peak})	±2100	±1425	±1050	±650	±325
b)	Switching impulse withstand voltage (250/2500 microsecond) (dry and wet)					
i)	between line terminals and ground (kV _{peak})	± 1550	± 1050	-NA-	-NA-	-NA-
c)	One minute power frequency dry withstand voltage (dry and wet)					
i)	between line terminals and ground (kV _{rms})	975 (dry only)	630 (dry only)	460	275	140
d)	One minute power frequency withstand voltage between secondary terminals & earth (kV _{rms})	5kV				
11	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at (microvolts)	2500 at 508 kV rms	1000 at 266kV rms	1000 at 156kV rms	500 at 92kV rms	-NA-
12	Minimum Corona extinction voltage (kV _{rms})	508	320	-NA-	-NA-	-NA-
13	Seismic acceleration (Horizontal)	0.3g	0.3g	0.3g	0.3g	-NA-
14	Partial Discharge	As per IEC				
15	Number of terminals	All terminals of control circuits are to be wired up to marshaling box plus 10% spare terminals evenly distributed on all TBs.				
16	Min. Creepage distance (mm) *	20000	10500	6125	3625	1813
17	System neutral earthing	Effectively Earthed				

*The values indicated are specific to creepage of 25mm/kV. In case of creepage of 31mm/kV is specified, the Minimum Creepage distance values shall be considered proportionately.

For other parameters, refer to the respective Table for the applicable voltage class of CTs.

9.2 MAJOR TECHNICAL PARAMETERS FOR CVT

S. No.	Description	765kV system	400kV system	220kV system	132 kV system	66 kV System (for tertiary loading)
1	Type (CVT/IVT)	CVT	CVT/IVT	CVT/IVT	CVT/IVT	CVT/IVT
2	Rated voltage, Um (kV _{rms})	800	420	245	145	72.5
3	Rated frequency (Hz)	50				
4	No. of Poles	1				
5	Design ambient temperature (°C)	50				
6	System fault level (kA)	50kA for 1 sec	63kA for 1 sec	50kA for 1 sec	40kA for 1sec	25kA for 3 sec
7	Standard reference range of frequencies for which the accuracies are valid	96% to 102% for protection and 99% to 101% for measurement				
8	High frequency capacitance for entire carrier frequency range (for CVT only)	Within 80% to 150% of rated capacitance				-
9	Equivalent series resistance over entire carrier frequency range (for CVT)	Less than 40 Ohms				-
10	Stray capacitance and stray conductance of HF terminal over entire carrier frequency range (for CVT)	As per IEC 60358				-
11	Temperature rise over design ambient temperature	As per IEC				
12	Rated Insulation levels					
a)	Full wave impulse withstand voltage (1.2/50 microsecond)					
i)	between line terminals and ground (kV _{peak})	±2100	±1425	±1050	±650	±325
b)	Switching impulse withstand voltage (250/2500 microsecond) (dry and wet)					
i)	between line terminals and ground (kV _{peak})	± 1550	± 1050	-NA-	-NA-	-NA-
c)	One minute power frequency dry withstand voltage (dry and wet)					
i)	between line terminals and ground (kV _{rms})	975 (dry only)	630 (dry only)	460	275	140
d)	One minute power frequency withstand voltage between secondary terminals & earth					
i)	between LV (HF) terminal and earth terminal (kVrms)	10kV _{rms} for exposed terminals and 4kVrms for terminals enclosed in a weatherproof box				
ii)	For secondary winding	3kVrms				
13	Max. radio interference voltage for frequency between 0.5MHz and 2MHz at (microvolts)	2500 at 508kV _{rms}	1000 at 66kV _{rms}	1000 at 156kV _{rms}	500 at 92kV _{rms}	-NA-
14	Min. Corona extinction voltage (kV _{rms})	508	320	-NA-	-NA-	-NA-
15	Seismic acceleration (Horizontal)	0.3g	0.3g	0.3g	0.3g	-NA-
16	Partial Discharge	As per IEC				
17	Number of terminals	All terminals of control circuits are to be wired up to marshaling box plus 10% spare terminals evenly distributed on all TBs.				
18	Rated Total Thermal Burden (VA)	300 VA (100VA/winding)				20VA
19	System neutral earthing	Effectively Earthed				
20	Min Creepage distance (mm) *	20000	10500	6125	3625	1813

*The values indicated are for specific creepage of 25mm/kV. In case of specific creepage of 31mm/kV is specified, the Minimum Creepage distance values shall be considered proportionately.

For other parameters, refer to the respective Table for the applicable voltage class of CVTs/IVTs.

TABLE – IA: REQUIREMENTS OF 800KV VOLTAGE TRANSFORMER

S. No.	Particulars	Parameters		
1	Rated primary voltage (kV rms)	800		
2	Type	Single phase capacitor VT		
3	No. of secondaries	3		
4	Rated voltage factor	1.2 - continuous 1.5 - 30 seconds		
5	Phase angle error	+ 10 minutes (For metering core)		
6	Capacitance (pf)	*4400/8800 (+ 10% / - 5%)		
7	Voltage Ratio	Secondary-I (765/√3)/(0.11/√3)	Secondary-II (765/√3)/(0.11/√3)	Secondary-III (765/√3)/(0.11/√3)
8	Application	Protection	Protection	Metering
9	Accuracy	0.5/3P	0.5/3P	0.2
10	Min. Output Burden (VA)	50	50	50

* Capacitance shall be as per BOQ.

TABLE – IB: REQUIREMENTS OF 420KV VOLTAGE TRANSFORMER

S. No.	Particulars	Parameters		
1	Rated primary voltage (kV rms)	420		
2	Type	Single phase Electromagnetic or Capacitor VT		
3	No. of secondaries	3		
4	Rated voltage factor	1.2 - continuous 1.5 - 30 seconds		
5	Phase angle error	+ 10 minutes (For metering core)		
6	Capacitance (pf)	*4400/8800 (+ 10% / - 5%)		
7	Voltage Ratio	Secondary-I (400/√3)/(0.11/√3)	Secondary-II (400/√3)/(0.11/√3)	Secondary-III (400/√3)/(0.11/√3)
8	Application	Protection	Protection	Metering
9	Accuracy	0.5 & 3P	0.5 & 3P	0.2
10	Burden	50	50	50

* Capacitance shall be as per BOQ.

TABLE – IC: REQUIREMENTS OF 245KV VOLTAGE TRANSFORMER

S. No.	Particulars	Parameters		
1	Rated primary voltage (kV rms)	245		
2	Type	Single phase Electromagnetic or Capacitor VT		
3	No. of secondaries	3		
4	Rated voltage factor	1.2 continuous 1.5 - 30 seconds		
5	Phase angle error	+ 10 minutes (For metering core)		

6	Capacitance (pf)	*4400/8800 (+ 10% / - 5%)		
7	Voltage Ratio	Secondary-I (220/√3)/(0.11/√3)	Secondary-II (220/√3)/(0.11/√3)	Secondary-III (220/√3)/(0.11/√3)
8	Application	Protection	Protection	Metering
9	Accuracy	0.5 & 3P	0.5 & 3P	0.2
10	Burden	50	50	50

* Capacitance shall be as per BOQ.

TABLE – ID: REQUIREMENTS OF 145KV VOLTAGE TRANSFORMER

S. No.	Particulars	Parameters		
1	Rated primary voltage (kV rms)	145		
2	Type	Single phase Electromagnetic or Capacitor VT		
3	No. of secondaries	3		
4	Rated voltage factor	1.2 - continuous 1.5 - 30 seconds		
5	Phase angle error	+ 10 minutes (For metering core)		
6	Capacitance (pf)	*4400/8800 (+ 10% / - 5%)		
7	Voltage Ratio	Secondary-I (132/√3)/(0.11/√3)	Secondary-II (132/√3)/(0.11/√3)	Secondary-III (132/√3)/(0.11/√3)
8	Application	Protection	Protection	Metering
9	Accuracy	0.5 & 3P	0.5 & 3P	0.2
10	Burden	50	50	50

* Capacitance shall be as per BOQ.

TABLE – IE: REQUIREMENTS OF 72.5KV VOLTAGE TRANSFORMER

S. No.	Particulars	Parameters	
1	Rated primary voltage (kV rms)	72.5	
2	Type	Single phase Electromagnetic or Capacitor VT	
3	No. of secondaries	2	
4	Rated voltage factor	1.2 - continuous 1.5 - 30 seconds	
5	Phase angle error	+ 20 minutes (For metering core)	
6	Voltage Ratio		
i).	For Tertiary loading (of ICT) application	Secondary-I (33/√3)/(0.11/√3)	Secondary-II (33/√3)/(0.11/√3)
ii).	For 66kV Feeder application	Secondary-I (66/√3)/(0.11/√3)	Secondary-II (66/√3)/(0.11/√3)
7	Application	Protection	Metering
8	Accuracy	3P	0.5
9	Burden	10	10

TABLE – IIA: REQUIREMENTS OF 800KV CURRENT TRANSFORMER

No of Core	Core No.	Application	Current Ratio	Output Burden (VA)	Accuracy Class	Min. Knee Point Voltage V_k (in V)	Max. CT Secondary winding Res. (in Ω)	Max. Excitation Current at V_k (in mA)
6	1	BUS DIFF. MAIN	3000/ 2000/ 500/1	-	PX	3000/ 2000/ 500	15/ 10/ 2.5	20 on 3000/1 tap, 30 on 2000/1 tap, 120 on 500/1 tap
	2	BUS DIFF. MAIN	3000/ 2000/ 500/1	-	PX	3000/ 2000/ 500	15/ 10/ 2.5	20 on 3000/1 tap, 30 on 2000/1 tap, 120 on 500/1 tap
	3	METERING	3000/ 2000/ 500/1	20	0.2S	-	-	-
	4	METERING	3000/ 2000/ 500/1	20	0.2S	-	-	-
	5	TRANSF DIFF./ LINE PROTN	3000/ 2000/ 500/1	-	PX	3000/ 2000/ 500	15/ 10/ 2.5	20 on 3000/1 tap, 30 on 2000/1 tap, 120 on 500/1 tap
	6	TRANSF DIFF./ LINE PROTN	3000/ 2000/ 500/1	-	PX	3000/ 2000/ 500	15/ 10/ 2.5	20 on 3000/1 tap, 30 on 2000/1 tap, 120 on 500/1 tap

Note: All Protection cores shall be of accuracy class **PX** and Metering Core shall be of accuracy class **0.2S** as per IEC 61869

TABLE – IIB: REQUIREMENTS OF 420KV CURRENT TRANSFORMER

No of Core	Core No.	Application	Current Ratio	Output Burden (VA)	Accuracy Class	Min. Knee Point Voltage V_k (in V)	Max. CT Secondary winding Res. (in Ω)	Max. Excitation Current at V_k (in mA)
6	1	BUS DIFF. MAIN	3000/ 2000/ 500/1	-	PX	3000/ 2000/ 500	15/ 10/ 2.5	20 on 3000/1 tap, 30 on 2000/1 tap, 120 on 500/1 tap
	2	BUS DIFF. MAIN	3000/ 2000/ 500/1	-	PX	3000/ 2000/ 500	15/ 10/ 2.5	20 on 3000/1 tap, 30 on 2000/1 tap, 120 on 500/1 tap
	3	METERING	3000/ 2000/ 500/1	20	0.2S	-	-	-
	4	METERING	3000/ 2000/ 500/1	20	0.2S	-	-	-
	5	TRANSF DIFF./ LINE PROTN	3000/ 2000/ 500/1	-	PX	3000/ 2000/ 500	15/ 10/ 2.5	20 on 3000/1 tap, 30 on 2000/1 tap, 120 on 500/1 tap
	6	TRANSF DIFF./ LINE PROTN	3000/ 2000/ 500/1	-	PX	3000/ 2000/ 500	15/ 10/ 2.5	20 on 3000/1 tap, 30 on 2000/1 tap, 120 on 500/1 tap

Note: All Protection cores shall be of accuracy class **PX** and Metering Core shall be of accuracy class **0.2S** as per IEC 61869

TABLE – IIC: REQUIREMENTS OF 245KV CURRENT TRANSFORMER

No of Core	Core No.	Application	Current Ratio	Output Burden (VA)	Accuracy Class	Min. Knee Point Voltage V_k (in V)	Max. CT Secondary winding Resistance (in Ω)	Max. Excitation Current at V_k (in mA)
5	1	BUS DIFF. MAIN	1600/800/1	-	PX	1600/800	8/4	25 on 1600/1 tap, 50 on 800/1 tap,
	2	BUS DIFF. CHECK	1600/800/1	-	PX	1600/800	8/4	25 on 1600/1 tap, 50 on 800/1 tap,
	3	METERING	1600/800/1	20	0.2S	-	-	-
	4	TRANSF DIFF./ LINE PROTN	1600/800/1	-	PX	1600/800	8/4	25 on 1600/1 tap, 50 on 800/1 tap,
	5	TRANSF DIFF./ LINE PROTN	1600/800/1	-	PX	1600/800	8/4	25 on 1600/1 tap, 50 on 800/1 tap,

Note: All Protection cores shall be of accuracy class **PX** and Metering Core shall be of accuracy class **0.2S** as per IEC 61869

TABLE – IID: REQUIREMENTS OF 145KV CURRENT TRANSFORMER

No of Core	Core No.	Application	Current Ratio	Output Burden (VA)	Accuracy Class	Min. Knee Point Voltage V_k (in V)	Max. CT Secondary winding Resistance (in Ω)	Max. Excitation Current at V_k (in mA)
5	1	BUS DIFF. MAIN	800/400/1	-	PX	800/400	8/4	25 on 800/1 tap, 50 on 400/1 tap,
	2	BUS DIFF. CHECK	800/400/1	-	PX	800/400	8/4	25 on 800/1 tap, 50 on 400/1 tap,
	3	METERING	800/400/1	20	0.2S	-	-	-
	4	TRANSF DIFF./ LINE PROTN	800/400/1	-	PX	800/400	8/4	25 on 800/1 tap, 50 on 400/1 tap,
	5	TRANSF DIFF./ LINE PROTN	800/400/1	-	PX	800/400	8/4	25 on 800/1 tap, 50 on 400/1 tap,

Note: All Protection cores shall be of accuracy class **PX** and Metering Core shall be of accuracy class **0.2S** as per IEC 61869

TABLE – IIE: REQUIREMENTS OF 72.5KV CURRENT TRANSFORMER

No. of Core	Core No.	Application	Current Ratio	Output Burden (VA)	Accuracy Class	Remarks
2	1	O/C & E/F	50/1	10	5P10	
	2	Metering	50/1	10	0.5	

Note:

1. All relaying CTs shall be of accuracy as per latest IS/IEC standards.