

TECHNICAL SPECIFICATIONS

CHAPTER 3B-SWITCHGEAR- INSTRUMENT TRANSFORMERS

for

PACKAGE KC-6

of

KOSHI CORRIDOR 220kV TRANSMISSION LINE PROJECT

IFB No.: KOSHI/NEA/KC-6

**Procurement of Design, Supply, Installation, Testing and
Commissioning of 220kV(GIS)/132kV Substation Expansion at
Dhangesanghu Substation**



नेपाल विद्युत प्राधिकरण
(नेपाल सरकारको स्वामित्व)
Nepal Electricity Authority
(A Government of Nepal Undertaking)

CHAPTER 3B-SWITCHGEAR

INSTRUMENT TRANSFORMERS

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 this specification and shall be in accordance with the requirements in Chapter 2-GTR.

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**

The instrument transformers shall be designed for use in geographic and meteorological conditions as given in Chapter 2-GTR **and Chapter 1-PSR.**

2.0 CONSTRUCTION FEATURES:

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

- a) Instrument transformers of **420kV/245kV/145kV/72.5/36** kV class, shall be oil filled/SF₆ gas filled, Dead Tank (Hair Pin or Eye Bolt)/Live Tank design suitable for outdoor service and upright mounting on steel structures. **245kV and 420kV** CT shall be with polymer insulator.
- b) Bushings/Insulators shall conform to requirements stipulated in Chapter 2-GTR. The bushing/insulator for CT shall be one piece without any metallic flange joint.
- c) Oil filling and drain plugs, oil sight glass shall be provided for CT & IVT. 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, 350 kg and 250 kg respectively for 420kV, 245kV, 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 furnish 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 gas 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 gas leakage. Provisions shall be made for online gas filling. Suitable rupture disc shall be provided to prevent explosion.
- g) The instrument transformers shall be complete with its terminal box and a common marshalling box for a set of 3 instrument transformers.
- h) The external surface of instrument transformer, if made of steel, shall be hot dip galvanized or painted as per Chapter 2-GTR. External surface of aluminum can have natural finish.
- i) The impregnation details alongwith tests/checks to ensure successful completion of impregnation cycle shall be furnished for approval.

2.2 Terminal box/Marshalling Box:

Terminal box/**Marshalling Box** shall conform to the requirements of Chapter 2- GTR.

2.3 Insulating Oil/Gas:

- a) Insulating oil to be used for instrument transformers shall be of EHV grade and shall conform to IEC-60296 (required for first filling). Non-PCB based synthetic insulating oil conforming to IEC 60867 **shall** be used in the capacitor units of CVT.
- b) The SF₆ gas shall comply with IEC-60376, 60376A, 60376B & **IEC-60480** and shall be suitable in all respects for use in the switchgear under operating conditions.

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

2.1 CURRENT TRANSFORMERS:

- a) Current transformers shall have single primary either ring type or hair pin type and suitably designed for bringing out the secondary terminals in a weather proof (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 of inverted type (**Live Tank**) current transformers, the manufacturer shall meet following additional requirements:

- (i) **The primary conductor shall preferably be of bar type meeting the desired characteristics.**
 - (ii) The secondaries shall be totally encased in metallic shielding providing a uniform equipotential surface for even electric field distribution.
 - (ii) The lowest part of the insulation assembly **i.e. insulation at neck** shall be properly secured to avoid any risk of damage due to transportation stresses.
 - (iii) 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.
 - (iv) **Bellows made of stainless steel shall be used at the top for hermetic sealing of CT.**
 - (v) Bidder/Manufacturer shall recommend whether any special storage facility is required for spare CT.
- b) Different ratios specified shall be achieved by secondary taps only and primary reconnection shall not be accepted.
 - c) 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.
 - 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) The secondary winding shall be rated for 2A continuously. The rated extended currents for 420kV class Current transformers shall be as given below:
 - Extended primary current (2000A) – 120% @ 2000/1, 180% @ 1000/1, 200% @ 500/1



- Extended primary current (4000A) – 120% @ 4000/1, 180% @ 2000/1, 200% @ 1000/1

For 245/145/72.5/36kV class CTs, the rated extended primary current shall be 120% (or 150% if applicable) on all cores of the CTs.

- h) For 420/245/145/72.5/36kV 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.
- i) 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.
- j) For 420/245/145/72.5/36kV 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 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 upto the terminal blocks.
- k) The wiring diagram plate for the interconnections of the three single phase CTs shall be provided inside the marshalling box.
- l) The Current Transformers should be suitable for mounting on lattice structure or pipe structure.
- m) The CT shall be designed so 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) 420/245/145kV Current Transformers shall be suitable for high speed auto reclosing.

4.0 VOLTAGE TRANSFORMERS:

- a) 420/245/145kV Voltage Transformers shall be capacitor voltage divider type with electromagnetic units and shall be suitable for carrier coupling.
- b) Voltage transformers secondaries 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.

- 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 500 KHz. 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.
- 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 ferroresonance oscillations.
- f) The accuracy of 0.2 on secondary III for all CVTs/IVTs should be maintained through out the entire burden range upto 50 VA on all the windings without any adjustments during operation.
- g) **The Voltage Transformers shall be suitable for mounting on lattice structure or Pipe structure.**
- 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, 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. **Alternate arrangement shall also be acceptable.**
- j) 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 given in Chapter 2-GTR and technical parameters for the respective equipment as per Annexure- I and Annexure-II of this specification.

6.0 TESTS:

- 6.1 In accordance with the requirements in Chapter 2-GTR, Current Transformer



and Voltage Transformer should have been type tested and shall be subjected to routine tests in accordance with **relevant IEC**.

- 6.2 The test reports of 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 following additional tests shall be submitted for the Employer's review. **The type tests for which the procedure is under consideration as per abovesaid IEC is not required to be considered.**

a) Current Transformers (CT):

- i) Corona test as per Chapter 2-GTR for **420kV voltage rating**.
- ii) RIV test as per IEC-61869 or as per Chapter 2- GTR for **145kV and above voltage rating**. However, RIV level shall be as specified at Annexure-II of this specification.
- iii) Seismic withstand test as per Chapter 2-GTR or IEC- 62271-2 (with Seismic acceleration requirement as per Annexure-I of this specification/Chapter 1-PSR) for **145kV and above voltage rating**.
- iv) Thermal stability test, i.e. application of rated voltage and rated extended thermal current simultaneously by synthetic test circuit **for 145kV and above voltage rating** (not applicable for SF₆ filled CT).
- v) 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 Um/√3) **for 145kV and above voltage rating** (not applicable for SF₆ filled CT).
- vi) Multiple chopped impulse test (not applicable for SF₆ filled CT) with the application of 600 chopped impulses **for 145kV and above voltage rating**.
- vii) Transmitted over voltage test for **145kV and above voltage rating**
- viii) Mechanical test (with minimum Cantilever load as per clause no. 2.1.c) for **145kV and above voltage rating**
- ix) Internal Arc fault test for **145kV and above voltage rating** (not applicable for CT with Polymer Insulator)
- x) Enclosure tightness test at low & high temperature for SF₆ filled CT of **145kV and above voltage rating**
- xi) Gas dew point test for SF₆ filled CT
- xii) Corrosion test for **145kV and above voltage rating**



b) Capacitive Voltage Transformers (CVT):

- i) High frequency capacitance and equivalent series resistance measurement (as per IEC-60358)
- ii) Seismic withstand test as per Chapter 2-GTR *or IEC-62271-2 (with Seismic acceleration requirement as per Annexure-II of this specification/Chapter 1-PSR)* for 145kV and above voltage class.
- iii) Stray capacitance and stray conductance measurement of the low voltage terminal (as per IEC-60358)
- iv) Corona test as per Chapter 2-GTR for 420kV voltage rating.
- v) RIV test as per IEC-61869 or as per Chapter 2- GTR for 145kV and above voltage rating. However, RIV level shall be as specified at Annexure-II of this specification.
- vi) Transmitted over voltage test for 145kV and above voltage rating
- vii) Mechanical test (with minimum Cantilever load as per clause no. 2.1.c) for 72.5kV and above voltage rating
- viii) Determination of Temperature coefficient for 145kV and above voltage rating
- ix) Tightness design test of capacitor units for 145kV and above voltage rating
- x) Corrosion test for 145kV and above voltage rating

c) Inductive Voltage Transformers (IVT):

- i) Seismic withstand test as per Chapter 2-GTR *or IEC-62271-2 (with Seismic acceleration requirement as per Annexure-II of this specification/Chapter 1-PSR)* for 145kV and above voltage rating.
- ii) Corona test as per Annexure-A of Chapter 2-GTR for 420kV and above voltage rating.
- ii) RIV test as per IEC-61869 or as per Annexure-A of Chapter 2-GTR for 145kV and above voltage rating. However, RIV level shall be as specified at Annexure-II of this specification.
- iii) Multiple chopped impulse test with application of 600 chopped impulses for 145kV and above voltage rating (not applicable for SF₆ filled CT).



- iv) **Transmitted over voltage test for 145kV and above voltage rating**
- v) **Mechanical test (with minimum Cantilever load as per clause no. 2.1.c) for 72.5kV and above voltage rating**
- vi) **Enclosure tightness test at low & high temperature for SF₆ filled CT of 145kV and above voltage rating**
- vii) **Gas dew point test for SF₆ filled CT**
- viii) **Corrosion test for 145kV and above voltage rating**
- ix) **Measurement of Capacitance and Dielectric dissipation factor for 145kV and above voltage rating**

6.3 The current and voltage transformer shall be subjected to the following routine tests in addition to routine tests as per *relevant* IEC:-

a) CURRENT TRANSFORMERS:

ROUTINE TESTS:

For Oil filled CT:

- i) Measurement of Capacitance.
- ii) Oil leakage test.
- iii) PF withstand on primary, secondary and between sections
- iv) PD Measurement
- v) Inter turn Voltage test
- vi) Measurement of tan delta at 0.3, 0.7, 1.0 and 1.1 Um/ $\sqrt{3}$.

For SF₆ filled CT:

- i) Dew point measurement
- ii) SF₆ alarm/ lockout check.
- iii) SF₆ gas leakage test: Gas leakage rate shall be maintained within 0.2% per annum.

b) VOLTAGE TRANSFORMERS:

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

7.0 MANDATORY SPARES:

Mandatory spares shall be as per BPS.

8.0 MAJOR TECHNICAL PARAMETERS:



Major technical parameters for 420kV/245kV/145kV/72.5kV Instrument Transformers are enclosed at Annexure-I and Annexure-II to this specification.

9.0 PRE-COMMISSIONING TESTS

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 Employer without any extra cost to the Employer. **The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates at his own cost.**

9.2 Current Transformers

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

CTs/IVTs must have adequate provision for taking oil samples from the bottom of the CT/IVT without exposure to atmosphere. 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. 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.

9.3 Inductive Voltage Transformers/Capacitive Voltage Transformers

- (a) Insulation Resistance test for primary (if applicable) and secondary winding
- (b) Polarity test
- (c) Ratio test



- (d) Dielectric test of oil (wherever applicable)
- (e) Tan delta and capacitance measurement of individual capacitor stacks
- (f) Secondary winding resistance measurement



TABLE - IA
REQUIREMENTS OF 400 KV VOLTAGE TRANSFORMER

S.No.	PARTICULAR	
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) (for CVT)	4400/8800* (+10% / - 5%)
7.	Core details	Core-1 Core-2 Core-3
	a) Voltage Ratio	$\frac{400/0.11}{\sqrt{3} \sqrt{3}}$ $\frac{400/0.11}{\sqrt{3} \sqrt{3}}$ $\frac{400/0.11}{\sqrt{3} \sqrt{3}}$
	b) Application	Protec- Protec- Meter- tion tion ing
	c) Accuracy	0.5&3P 0.5&3P 0.2
	d) Min. Output burden (VA)	50 50 50

* Capacitance value shall be as specified in Chapter PSR/BPS.



TABLE - IB
REQUIREMENTS OF 220 KV VOLTAGE TRANSFORMER

S.No.	PARTICULAR	
1.	Rated primary voltage (kV rms)	245
2.	Type	Single phase Electromagnetic or Capacitor VT
3.	No. of secondaries	3 cores
4.	Rated voltage factor	1.2 continuous 1.5 - 30 seconds
5.	Phase angle error	± 10 minutes (For metering core)
6.	Capacitance (pf) (for CVT)	4400 (+10% / - 5%)
7.	Core details	Core-1 Core-2 Core-3
	a) Voltage Ratio	$\frac{220/0.11}{\sqrt{3} \sqrt{3}}$ $\frac{220/0.11}{\sqrt{3} \sqrt{3}}$ $\frac{220/0.11}{\sqrt{3} \sqrt{3}}$
	b) Application	Protec- tion Protec- tion Meter- ing
	c) Accuracy	3P 3P 0.2
	d) Min. Output burden (VA)	50 50 50



TABLE - IC
REQUIREMENTS OF 132 KV VOLTAGE TRANSFORMER

S.No.	PARTICULAR	
1.	Rated primary voltage (kV rms)	145
2.	Type	Single phase Electromagnetic or Capacitor VT
3.	No. of secondaries	3 cores
4.	Rated voltage factor	1.2 continuous 1.5 - 30 seconds
5.	Phase angle error	± 10 minutes (For metering core)
6.	Capacitance (pf) (for CVT)	4400 (+ 10% / -5%)
7.	Core details	Core-1 Core-2 Core-3
	a) Voltage Ratio	$\frac{132/0.11}{\sqrt{3} \sqrt{3}}$ $\frac{132/0.11}{\sqrt{3} \sqrt{3}}$ $\frac{132/0.11}{\sqrt{3} \sqrt{3}}$
	b) Application	Protec- Protec- Meter- tion tion ing
	c) Accuracy	3P 3P 0.2
	d) Min. Output burden (VA)	50 50 50



TABLE - ID
REQUIREMENTS OF 66 KV VOLTAGE TRANSFORMER

S.No.	PARTICULAR			
1.	Rated primary voltage (kV rms)	72.5		
2.	Type	Single phase Electro-magnetic or Capacitive VT		
3.	No. of secondaries	3 cores		
4.	Rated Voltage Factor	1.2 continuous 1.5 – 30 seconds		
5.	Phase angle error	+ 20 minutes (For metering core)		
6.	Core details	Core-1	Core-2	Core-3
	a) Voltage ratio	For 66 kV feeder application $66/\sqrt{3} / 0.11/\sqrt{3}$ For tertiary loading (of ICT) application $33/\sqrt{3} / 0.11/\sqrt{3}$		
	b) Application	Protection	Protection	Metering
	c) Accuracy	3P	3P	0.2
	d) Output Burden (VA) (minimum)	50	50	50



TABLE - IE
REQUIREMENTS OF 33 KV VOLTAGE TRANSFORMER

S.No.	PARTICULAR	
1.	Rated primary voltage (kV rms)	36
2.	Type	Single phase PT
3.	No. of secondaries	3 cores
4.	Rated voltage factor	1.2 continuous 1.5 - 30 seconds
5.	Phase angle error	+ 20 minutes (For metering core)
6.	Core details	Core-1 Core-2 Core-3
	a) Voltage Ratio	$\frac{33/0.11}{\sqrt{3} \sqrt{3}}$ $\frac{33/0.11}{\sqrt{3} \sqrt{3}}$ $\frac{33/0.11}{\sqrt{3} \sqrt{3}}$
	b) Application	Protec- Protec- Meter- tion tion ing
	c) Accuracy	3P 3P 0.2
	d) Min. Output burden (VA)	50 50 50



TABLE-IIA**REQUIREMENTS FOR 420 KV CURRENT TRANSFORMER**

No. of cores	Core No.	Application	Ratio	Output Burden	Accuracy Class	Min. Knee Pt. Voltage (Vk)	Max. CT Sec. wdg. Resistance (in Ω)	Max. Excit. Current at Vk (in mA)
6	1	BUS DIFF. CHECK	4000/ 2000/ 1000/1	-	PX	4000/ 2000/ 1000	15/10/5	20 on 4000/1 TAP; 30 on 2000/1; 60 on 1000/1 tap
	2.	BUS DIFF. MAIN	4000/ 2000/ 1000/1	-	PX	4000/ 2000/ 1000	15/10/5	20 on 4000/1 TAP; 30 on 2000/1; 60 on 1000/1 tap
	3.	METERING	4000/ 2000/ 1000/1	20 20 20	0.2S 0.2S 0.2S	- - -		- - -
	4.	METERING	4000/ 2000/ 500/1	20 20 20	0.2S 0.2S 0.2S	- - -		- - -
	5.	TRANS. BACK UP/LINE PROTN.	4000/ 2000/ 1000/1	-	PX	4000/ 2000/ 1000	15/10/5	20 on 4000/1 TAP; 30 on 2000/1; 60 on 1000/1 tap
	6.	TRANS. DIFF. /LINE PROTN.	4000/ 2000/ 1000/1	-	PX	4000/ 2000/ 1000	15/10/5	20 on 4000/1 TAP; 30 on 2000/1; 60 on 1000/1 tap

Note: 1. Protection cores shall be of accuracy class PX as per IEC 61869.

2. Metering Core shall be of accuracy class 0.2S as per IEC: 61869



TABLE-IIB**REQUIREMENTS FOR 420 KV CURRENT TRANSFORMER**

No. of cores	Core No.	Application	Ratio	Output Burden	Accuracy Class	Min. Knee Pt. Voltage (Vk)	Max. CT Sec. wdg. Resistance (in Ω)	Max. Excit. Current at Vk (in mA)
6	1	BUS DIFF. CHECK	2000/ 1000/ 500/1	-	PX	2000/ 1000/ 500	10/5/2.5	30 on 2000/1 TAP; 60 on 1000/1; 120 on 500/1 tap
	2.	BUS DIFF. MAIN	2000/ 1000/ 500/1	-	PX	2000/ 1000/ 500	10/5/2.5	30 on 2000/1 TAP; 60 on 1000/1; 120 on 500/1 tap
	3.	METERING	2000/ 1000/ 500/1	20 20 20	0.2S 0.2S 0.2S	- - -		- - -
	4.	METERING	2000/ 1000/ 1000/1	20 20 20	0.2S 0.2S 0.2S	- - -		- - -
	5.	TRANS. BACK UP/LINE PROTN.	2000/ 1000/ 500/1	-	PX	2000/ 1000/ 500	10/5/2.5	30 on 2000/1 TAP; 60 on 1000/1; 120 on 500/1 tap
	6.	TRANS. DIFF. /LINE PROTN.	2000/ 1000/ 500/1	-	PX	2000/ 1000/ 500	10/5/2.5	30 on 2000/1 TAP; 60 on 1000/1; 120 on 500/1 tap

Note: 1. Protection cores shall be of accuracy class PX as per IEC 61869.

2. Metering Core shall be of accuracy class 0.2S as per IEC: 61869



TABLE - IIC
REQUIREMENTS FOR 245 KV CURRENT TRANSFORMER

No.of Cores	Core No.	Appli-cation	Current ratio	Output burden (VA)	Accuracy class	Min. knee pt.volt-age (Vk)	Max. CT sec.wdg. resist-ance(ohms)	Max. Excit-ation cur-rent at Vk (in mA)
5	1	BUS DIFF CHECK	3000-2000/1	-	PX	3000/2000	15/10	10 on 3000/1 Tap; 30 on 2000/1 Tap
	2	BUS DIFF MAIN	3000-2000/1	-	PX	3000/2000	15/10	10 on 3000/1 Tap; 30 on 2000/1 Tap
	3	METERING	3000-2000/1	20	0.2S	-	-	-
	4	TRANS. BACK UP/LINE PROTN.	3000-2000/1	-	PX	3000/2000	15/10	10 on 3000/1 Tap; 30 on 2000/1 Tap
	5	TRANS. DIFF/LINE PROTN	3000-2000/1	-	PX	3000/2000	15/10	10 on 3000/1 Tap; 30 on 2000/1 Tap

Note: 1. Protection cores shall be of accuracy class PX as per IEC 61869.

2. Metering Core shall be of accuracy class 0.2S as per IEC: 61869



TABLE - IID
REQUIREMENTS FOR 245 KV CURRENT TRANSFORMER

No.of Cores	Core No.	Appli-cation	Current ratio	Output burden (VA)	Accuracy class	Min. knee pt.volt-age (Vk)	Max. CT sec.wdg. resist-ance(ohms)	Max. Excit-ation cur-rent at Vk (in mA)
5	1	BUS DIFF CHECK	2000-1000/1	-	PX	2000/1000	10/5	30 on 2000/1 Tap; 60 on 1000/1 Tap
	2	BUS DIFF MAIN	2000-1000/1	-	PX	2000/1000	10/5	30 on 2000/1 Tap; 60 on 1000/1 Tap
	3	METERING	2000-1000/1	20	0.2S	-	-	-
	4	TRANS. BACK UP/LINE PROTN.	2000-1000/1	-	PX	2000/1000	10/5	30 on 2000/1 Tap; 60 on 1000/1 Tap
	5	TRANS. DIFF/LINE PROTN	2000-1000/1	-	PX	2000/1000	10/5	30 on 2000/1 Tap; 60 on 1000/1 Tap

Note: 1. Protection cores shall be of accuracy class PX as per IEC 61869.

2. Metering Core shall be of accuracy class 0.2S as per IEC: 61869



TABLE - IIE
REQUIREMENTS FOR 245 KV CURRENT TRANSFORMER

No.of Cores	Core No.	Appli-cation	Current ratio	Output burden (VA)	Accuracy class	Min. knee pt.volt-age (Vk)	Max. CT sec.wdg. resist-ance(ohms)	Max. Excit-ation cur-rent at Vk (in mA)
5	1	BUS DIFF CHECK	1600-800/1	-	PX	1600/800	8/4	25 on 1600/1 Tap; 50 on 800/1 Tap
	2	BUS DIFF MAIN	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	TRANS. BACK UP/LINE PROTN.	1600-800/1	-	PX	1600/800	8/4	25 on 1600/1 Tap; 50 on 800/1 Tap
	5	TRANS. DIFF/LINE PROTN	1600-800/1	-	PX	1600/800	8/4	25 on 1600/1 Tap; 50 on 800/1 Tap

Note: 1. Protection cores shall be of accuracy class PX as per IEC 61869.

2. Metering Core shall be of accuracy class 0.2S as per IEC: 61869



TABLE - IIF
REQUIREMENTS FOR 145 KV CURRENT TRANSFORMER

No.of Cores	Core No.	Appli- cation	Current ratio	Output burden (VA)	Accuracy class	Min. knee pt.volt- age Vk	Max. CT sec.wdg. resist- ance(ohms)	Max. Excit- ation cur- rent at Vk (in mA)
5	1	BUS DIFF CHECK	2000- 1000/1	-	PX	2000/ 1000	10/5	30 on 2000/1 Tap; 60 on 1000/1 Tap
	2	BUS DIFF MAIN	2000- 1000/1	-	PX	2000/ 1000	10/5	30on 2000/1 Tap; 60 on 1000/1 Tap
	3	METERING	2000- 1000/1	20	0.2S	-	-	-
	4	TRANS. BACK UP/LINE PROTN.	2000- 1000/1	20	5P20	-	-	-
	5	TRANS. DIFF/LINE PROTN	2000- 1000/1	-	PX	2000/ 1000	10/5	30 on 2000/1 Tap; 60 on 1000/1 Tap

Note: 1. Protection cores shall be of accuracy class PX as per IEC 61869.

2. Metering Core shall be of accuracy class 0.2S as per IEC: 61869



TABLE - IIG
REQUIREMENTS FOR 145 KV CURRENT TRANSFORMER

No.of Cores	Core No.	Appli- cation	Current ratio	Output burden (VA)	Accuracy class	Min. knee pt.volt- age Vk	Max. CT sec.wdg. resist- ance(ohms)	Max. Excit- ation cur- rent at Vk (in mA)
5	1	BUS DIFF CHECK	1200-600/1	-	PX	1200/600	10/5	30 on 1200/1 Tap; 60 on 600/1 Tap
	2	BUS DIFF MAIN	1200-600/1	-	PX	1200/600	10/5	30 on 1200/1 Tap; 60 on 600/1 Tap
	3	METERING	1200-600/1	20	0.2S	-	-	-
	4	TRANS. BACK UP/LINE PROTN.	1200-600/1	20	5P20	-	-	-
	5	TRANS. DIFF/LINE PROTN	1200-600/1	-	PX	1200/600	10/5	30 on 1200/1 Tap; 60 on 600/1 Tap

Note: 1. Protection cores shall be of accuracy class PX as per IEC 61869.

2. Metering Core shall be of accuracy class 0.2S as per IEC: 61869



TABLE – IIIH
REQUIREMENTS FOR 145 kV CURRENT TRANSFORMER

No.of Cores	Core No.	Appli-cation	Current ratio	Output burden (VA)	Accuracy class	Min. knee pt.volt-age Vk	Max. CT sec.wdg. resist-ance(ohms)	Max. Excit-ation cur-rent at Vk (in mA)
5	1	BUS DIFF CHECK	800-400/1	-	PX	800/400	8/4	30 on 800/1 Tap; 60 on 400/1 Tap
	2	BUS DIFF MAIN	800-400/1	-	PX	800/400	8/4	30 on 800/1 Tap; on 400/1 Tap
	3	METERING	800-400/1	20	0.2S	-	-	-
	4	TRANS. BACK UP/LINE PROTN.	800-400/1	20	5P20	-	-	-
	5	TRANS. DIFF/LINE PROTN	800-400/1	-	PX	800/400	8/4	30 on 800/1 Tap; 60 on 400/1 Tap

Note: 1. Protection cores shall be of accuracy class PX as per IEC 61869.

2. Metering Core shall be of accuracy class 0.2S as per IEC: 61869



TABLE – II I
REQUIREMENTS FOR 66 KV CURRENT TRANSFORMER

No.of Cores	Core No.	Appli-cation	Current ratio	Output burden (VA)	Accuracy class	Min. knee pt.volt-age Vk	Max. CT sec.wdg. resist-ance(ohms)	Max. Excit-ation cur-rent at Vk (in mA)
5	1	BUS DIFF CHECK	2000-1000/1	-	PX	2000/1000	10/5	30 on 2000/1 Tap; 60 on 1000/1 Tap
	2	BUS DIFF MAIN	2000-1000/1	-	PX	2000/1000	10/5	30 on 2000/1 Tap; 60 on 1000/1 Tap
	3	METERING	2000-1000/1	20	0.2S	-	-	-
	4	TRANS. BACK UP/LINE PROTN.	2000-1000/1	20	5P20	-	-	-
	5	TRANS. DIFF/LINE PROTN	2000-1000/1	-	PX	2000/1000	10/5	30 on 2000/1 Tap; 60 on 1000/1 Tap

Note: 1. Protection cores shall be of accuracy class PX/5P20 as per IEC 61869.
2. Metering Core shall be of accuracy class 0.2S as per IEC: 61869



TABLE - IIJ
REQUIREMENTS FOR 66 KV CURRENT TRANSFORMER

No.of Cores	Core No.	Appli- cation	Current ratio	Output burden (VA)	Accuracy class	Min. knee pt.volt- age Vk	Max. CT sec.wdg. resist- ance(ohms)	Max. Excit- ation cur- rent at Vk (in mA)
5	1	BUS DIFF CHECK	800- 400/1	-	PX	800/ 400	8/4	25 on 1200/1 Tap; 50 on 600/1 Tap
	2	BUS DIFF MAIN	800- 400/1	-	PX	800/ 400	8/4	25 on 1200/1 Tap; 50 on 600/1 Tap
	3	METERING	800- 400/1	20	0.2S	-	-	-
	4	TRANS. BACK UP/LINE PROTN.	800- 400/1	20	5P20	-	-	-
	5	TRANS. DIFF/LINE PROTN	800- 400/1	-	PX	800/ 400	8/4	25 on 1200/1 Tap; 50 on 600/1 Tap

Note: 1. Protection cores shall be of accuracy class PX/5P20 as per IEC 61869.

2. Metering Core shall be of accuracy class 0.2S as per IEC: 61869



TABLE – IIK

**REQUIREMENTS FOR 66 kV CURRENT TRANSFORMER
(FOR TERTIARY LOADING OF ICT)**

No. of Cores	Core No.	Application	Current Ratio	Output burden (VA)	Accuracy class & ALF
2	1	O/C & E/F	50-25/1	15	5P20
	2	Metering	50-25/1	15	0.2



TABLE – IIL
REQUIREMENTS FOR 33 kV CURRENT TRANSFORMERS

No.of Cores	Core No.	Appli- cation	Current ratio	Output burden(VA)	Accuracy class as per IEC:	Min. knee pt.volt- age Vk (Volts)	Max.CT sec.wdg. resistance (in ohms)	Max.Excit- ation current at Vk
4	1 & 4	O/C & E/F 50BF	2000- 1000/1	15	5P20		-	-
	2	METERING	2000- 1000/1	15	0.2S	-	-	-
	3	TRANS. DIFF PROT N	2000- 1000/1	-	PX	2000/ 1000	20/ 10	30 on 2000/1 Tap 60 on 1000/1 Tap

TABLE – IIM
REQUIREMENTS FOR 33 kV CURRENT TRANSFORMERS

No.of Cores	Core No.	Appli- cation	Current ratio	Output burden(VA)	Accuracy class as per IEC:	Min. knee pt.volt- age Vk (in mA)	Max.CT sec.wdg. resis- tance(ohms)	Max.Excit- ation cur- rent at Vk	Remarks
4	1 & 4	O/C & E/F 50BF	1200- 600/1	15	5P20		-	-	-
	2	METERING	1200- 600/1	15	0.2S	-	-	-	
	3	TRANS. DIFF PROT N	1200- 600/1	-	PX	1200/ 600	12/ 6	30 on 1200/1 Tap 60 on 600/1 Tap	

TABLE – IIN



REQUIREMENTS FOR 33 kV CURRENT TRANSFORMERS

No.of Cores	Core No.	Appli- cation	Current ratio	Output burden(VA)	Accuracy class as per IEC:	Min. knee pt.volt- age Vk ance(ohms) (in mA)	Max.CT sec.wdg. resis-	Max.Excit- ation cur- rent at Vk	Remarks
4	1&4	O/C & E/F 50BF	600- 300-150/1	-	5P20	-	-	-	
	2	METERING	600- 300-150/1	15	0.2 s	-	-	-	
	3	TRANS. DIFF PROTN	600- 300-150/1	-	PX	1200/ 600	8/ 4	25 on 600/1 Tap 50 on 300/1 Tap	

**TABLE – IIO
REQUIREMENTS FOR 33 kV CURRENT TRANSFORMERS**

No.of Cores	Core No.	Appli- cation	Current ratio	Output burden(VA)	Accuracy class as per IEC:	Min. knee pt.volt- age Vk ance(ohms) (in mA)	Max.CT sec.wdg. resis-	Max.Excit- ation cur- rent at Vk	Remarks
3	1 & 3	O/C & E/F 50BF	400- 200-100/1	-	5P20	-	-	-	
	2	METERING	400- 200-100/1	15	0.2 s	-	-	-	

**TABLE – IIP
REQUIREMENTS FOR 33 kV CURRENT TRANSFORMERS
(FOR STATION TRANSFORMER if applicable)**

No. of Cores	Core No.	Application	Current Ratio	Output burden (VA)	Accuracy class & ALF
2	1	O/C & E/F	50-25/1	15	5P20
	2	Metering	50-25/1	15	0.2s

Annexure-I

MAJOR TECHNICAL PARAMETERS FOR CT

S. No.	Description	400kV system	220kV system	132 kV system	66 kV System	33 kV System
1	Rated voltage, U_m (kVrms)	420	245	145	72.5	36
2	Rated frequency (Hz)	50	50	50	50	50
3	No. of Poles	1	1	1	1	1
4	Design ambient temperature ($^{\circ}\text{C}$)	50	50	50	50	50
5	Rated Primary Current (A)	As per PSR/BPS	As per PSR/BPS	As per PSR/BPS	As per PSR/BPS	As per PSR/BPS
6	Rated short time thermal withstand current	63kA for 1 sec	50kA for 1 sec	40kA for 1sec	40 kA for 1sec & 25kA for 3sec (for tertiary application)	31.5 kA for 1sec
7	Rated dynamic current	157.5kAp	125kAp	100kAp	100kAp	80kAp
8	Temperature rise over design ambient temperature					
9	Rated Insulation levels					
a)	Full wave impulse withstand voltage (1.2/50 microsecond)					
i)	between line terminals and ground(kVpeak)	± 1425	± 1050	± 650	± 325	± 170
b)	Switching impulse withstand voltage (250/2500 microsecond) (dry and wet)					
i)	between line terminals and ground (kVpeak)	± 1050	-NA-	-NA-	-NA-	-NA-
c)	One minute power frequency dry withstand voltage (dry and wet)					
i)	between line terminals and ground (kVrms)	630 (dry only)	460	275	140	70



S. No.	Description	400kV system	220kV system	132 kV system	66 kV System	33 kV System
d)	One minute power frequency withstand voltage between secondary terminals & earth (kVrms)	5 kV				
10	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at (microvolts)	1000 at 266kV rms	1000 at 156kV rms	500 at 92kV rms	-NA-	-NA-
11	Minimum Corona extinction voltage (kVrms)	320	-NA-	-NA-	-NA-	-NA-
12	Seismic acceleration (Horizontal)	As per PSR	As per PSR	As per PSR	-NA-	-NA-
14	Partial Discharge	As per IEC	As per IEC	As per IEC	As per IEC	As per IEC
15	Number of terminals	All terminals of control circuits are to be wired up to marshaling box plus 20% spare terminals evenly distributed on all TBs.				
16	Minimum Creepage distance (mm) *	10500	6125	3625	1813	900
17	System neutral earthing	Effectively Earthed				

*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 respective Table for the applicable voltage class of CTs. **For bays with lesser rated current, the ratio may be decreased but the CT PX class must be designed such that CT saturation doesn't occur for the fault level specified in PSR/GTR/chapter for busbar differential and maximum fault current for transformer differential.**

Annexure-II

MAJOR TECHNICAL PARAMETERS FOR CVT/IVT

S. No.	Description	400kV system	220kV system	132 kV system	66 kV	33 kV
1	Type (CVT/IVT)	CVT/IVT	CVT/IVT	CVT/IVT	CVT/IVT	CVT/IVT
2	Rated voltage, U_m (kVrms)	420	245	145	72.5	36



S. No.	Description	400kV system	220kV system	132 kV system	66 kV	33 kV
3	Rated frequency (Hz)	50	50	50	50	50
4	No. of Poles	1	1	1	1	1
5	Design ambient temperature (°C)	50	50	50	50	50
6	System fault level (kA)	63kA for 1 sec	50kA for 1 sec	40kA for 1sec	40kA for 1sec 25kA for 3sec (for tertiary loading)	31.5kA for 1sec
6	Standard reference range of frequencies for which the accuracies are valid	96% to 102% for protection and 99% to 101% for measurement				
7	High frequency capacitance for entire carrier frequency range (for CVT only)	Within 80% to 150% of rated capacitance			-	-
8	Equivalent series resistance over entire carrier frequency range (for CVT)	Less than 40 Ohms			-	-
9	Stray capacitance and stray conductance of HF terminal over entire carrier frequency range (for CVT)	As per IEC-60358			-	-
10	Temperature rise over design ambient temperature	As per IEC				
11	Rated Insulation levels					
a)	Full wave impulse withstand voltage (1.2/50 microsecond)					
i)	between line terminals and ground (kVpeak)	±1425	±1050	±650	±325	±170
b)	Switching impulse withstand voltage (250/2500 microsecond) (dry and wet)					



S. No.	Description	400kV system	220kV system	132 kV system	66 kV	33 kV
i)	between line terminals and ground (kVpeak)	± 1050	-NA-	-NA-	-NA-	-NA-
c)	One minute power frequency dry withstand voltage (dry and wet)					
i)	between line terminals and ground (kVrms)	630 (dry only)	460	275	140	70
d)	One minute power frequency withstand voltage between secondary terminals & earth					
i)	between LV (HF) terminal and earth terminal (kVrms)	10kVrms for exposed terminals and 4kVrms for terminals enclosed in a weather proof box				
ii)	For secondary winding	3kVrms				
11	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at (microvolts)	1000 at 266kV rms	1000 at 156kV rms	500 at 92kV rms	-NA-	-NA-
12	Minimum Corona extinction voltage (kVrms)	320	-NA-	-NA-	-NA-	-NA-
13	Seismic acceleration (Horizontal)	As per PSR	As per PSR	As per PSR	-NA-	-NA-
14	Partial Discharge	As per IEC	As per IEC	As per IEC	As per IEC	As per IEC
15	Number of terminals	All terminals of control circuits are to be wired up to marshaling box plus 20% spare terminals evenly distributed on all TBs.				
16	Rated Total Thermal Burden (VA)	(50VA/winding)			50VA/winding	
17	System neutral earthing	Effectively Earthed				
	Minimum Creepage distance (mm) *	10500	6125	3625	1813	900

*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 respective Table for the applicable voltage class of CVTs/IVTs.

