Eskom	Standard	Technology

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1. Introduction

This standard stipulates Eskom's requirements for designing, manufacturing and testing of top core current transformers rated from 132kV up to 765kV. The requirements stipulated in this document are based on international practices combined with Eskom's experiences. The requirements are specified in order to ensure the integrity of the products thereby minimising the risk of failure of equipment.

2. Supporting clauses

2.1 Scope

This standard details the requirements applicable to top core current transformers used in Eskom from nominal voltage of 132kV up to 765kV.

2.1.1 Purpose

The document is written to capture and standardise Eskom top core current transformer requirements.

2.1.2 Applicability

This document shall apply to Eskom Transmission.

2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] IEC 60060-1: High voltage test techniques – Part 1: General definitions and test requirements

[2] IEC 60071-1: Insulation co-ordination – Part 1: Definitions, principles and rules

[3] IEC 60085: Electrical insulation – Thermal classification

[4] IEC 60270: High voltage test techniques – Partial discharge measurements

[5] IEC 60296: Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear

[6] IEC 60455 (all parts): Resin based reactive compounds used for electrical insulation

[7] IEC 60529: Degrees of protection provided by enclosures (IP code)

[8] IEC 60694: Common specifications for high-voltage switchgear and controlgear standards

[9] IEC 60815: Guide for the selection of insulators in respect of polluted conditions

[10] IEC 61869-1: Instrument Transformers – Part 1: General

[11] IEC 61869-2: Instrument Transformers – Part 2: Additional requirements for current transformers

[12] IEC 62271-2: High-voltage switchgear and controlgear – Part 2: Seismic qualification for rated voltages of 72.5 kV and above.

[13] IEC TR 62271-301: High Voltage Switchgear and Controlgear – Part 301: Dimensional Standardisation of High Voltage Terminals

[14] CISPR 18-2: Radio interference characteristics of overhead power lines and high-voltage equipment – Part 2: Methods of measurement and procedure for determining limits

[15] Note: Some IEC documents mentioned above are available from SABS with the same number preceded by SANS.

2.2.2 Informative

None

2.3 Definitions

2.3.1 General

Definition	Description
Accuracy class	a designation assigned to an instrument transformer, the ratio error and phase displacement of which remain within specified limits under prescribed conditions of use
Accuracy limit factor (ALF)	ratio of the rated accuracy limit primary current to the rated primary current
Burden	admittance (or impedance) of the secondary circuit expressed in siemens (or ohms) and power factor
Class P protective current transformer	protective current transformer without remanent flux limit, for which the saturation behaviour in the case of a symmetrical short-circuit is specified
Class PX protective current transformer	protective current transformer of low-leakage reactance without remanent flux limit for which knowledge of the excitation characteristic and of the secondary winding resistance, secondary burden resistance and turns ratio, is sufficient to assess its performance in relation to the protective relay system with which it is to be used
Class TPY protective current transformer	protective current transformer with remanent flux limit, for which the saturation behaviour in case of a transient short-circuit current is specified by the peak value of the instantaneous error
Composite error (ε_c)	under steady-state conditions, the r.m.s. value of the difference between the instantaneous values of the primary current, and the instantaneous values of the actual secondary current multiplied by the rated transformation ratio with the positive signs of the primary and secondary currents corresponding to the convention for terminal markings
Creepage Distance	shortest distance, or the sum of the shortest distances, along the insulating parts of the insulator between those parts which normally have the operating voltage between them
Current transformer	instrument transformer in which the secondary current, under normal conditions of use, is substantially proportional to the primary current and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections
Duration of first fault (t')	duration of the fault in a C-O duty cycle, or of the first fault in a C-O-C-O duty cycle
Duration of second fault (t'')	duration of the second fault in a C-O-C-O duty cycle
Enclosure	housing affording the type and degree of protection suitable for the intended application
Exciting current (I_e)	r.m.s. value of the current taken by the secondary winding of a current transformer, when a sinusoidal voltage of rated frequency is applied to the secondary terminals, the primary and any other windings being open-circuited

Definition	Description
Fault repetition time (t_{fr})	time interval between interruption and re-application of the primary short-circuit current during a circuit breaker auto-reclosing duty cycle in case of a non-successful fault clearance
Highest voltage for equipment (U_m)	the highest r.m.s. value of phase-to-phase voltage for which the equipment is designed in respect of its insulation as well as other characteristics which relate to this voltage in the relevant equipment standards
Instrument security factor (FS)	ratio of rated instrument limit primary current to the rated primary current
Knee point e.m.f.	e.m.f. of a current transformer at rated frequency, which, when increased by 10%, causes the r.m.s. value of the exciting current to increase by 50%
Measuring current transformer	current transformer intended to transmit an information signal to measuring instruments and meters
Mechanical load (F)	forces on different parts of the instrument transformer as a function of four main forces: • forces on the terminals due to the line connections • forces due to the wind • seismic forces • electro dynamic forces due to short circuit current
Nominal voltage of a system (U_n)	highest value of the phase-to-phase operating voltage (r.m.s. value) which occurs under normal operating conditions at any time and at any point in the system
Peak value of exciting secondary current at Eal (I_{al})	peak value of the exciting current when a voltage corresponding to E_{al} is applied to the secondary terminals while the primary winding is open
Phase displacement (Δϕ)	difference in phase between the primary voltage or current and the secondary voltage or current phasors, the direction of the phasors being so chosen that the angle is zero for an ideal transformer
Primary terminals	terminals to which the voltage or current to be transformed is applied
Protective current transformer	a current transformer intended to transmit an information signal to protective and control devices
Rated burden	value of the burden on which the accuracy requirements of this specification are based
Rated dynamic current (I_{dyn})	maximum peak value of the primary current which a transformer will withstand, without being damaged electrically or mechanically by the resulting electromagnetic forces, the secondary winding being short-circuited
Rated equivalent limiting secondary e.m.f. (E_{al})	that r.m.s. value of the equivalent secondary circuit e.m.f. at rated frequency necessary to meet the requirements of the specified duty cycle.
Rated frequency (f_R)	value of the frequency on which the requirements of this standard are based
Rated insulation level	combination of voltage values which characterizes the insulation of a current transformer with regard to its capability to withstand dielectric stresses
Rated knee-point e.m.f (E_k)	lower limit of the knee point e.m.f.

Definition	Description
Rated primary current (I_{pr})	value of the primary current on which the performance of the transformer is based
Rated primary short-circuit current (I_{psc})	r.m.s. value of the a.c. component of a transient primary short-circuit current on which the accuracy performance of a current transformer is based
Rated resistive burden (R_b)	rated value of the secondary connected resistive burden in ohms
Rated secondary current (I_{sr})	value of the secondary current on which the performance of the transformer is based
Rated short-time thermal current (I_{th})	maximum value of the primary current which a transformer will withstand for a specified short time without suffering harmful effects, the secondary winding being short-circuited
Rated symmetrical short-circuit current factor (K_{ssc})	ratio of the rated primary short circuit current to the rated primary current
Rated turns ratio	specified ratio of the number of primary turns to the number of secondary turns
Ratio error (ε)	the error which an instrument transformer introduces into the measurement and which arises from the fact that the actual transformation ratio is not equal to the rated transformation ratio
Secondary terminals	terminals which transmit an information signal to measuring instruments, meters and protective or control devices or similar apparatus
Secondary winding resistance (R_{ct})	actual secondary winding d.c. resistance in ohms corrected to 75ºC or such other temperature as may be specified
Section	electrically conductive part of an instrument transformer insulated from other similar parts and equipped with terminals
Specified duty cycle (C-O and / or C-O-C-O)	duty cycle in which, during each specified energization, the primary short circuit current is assumed to have the worst-case inception angle
Specified primary time constant (T_p)	that specified value of the time constant of the d.c. component of the primary short-circuit current on which the transient performance of the current transformer is based
Specified time to accuracy limit in the first fault t'_{al}	time in a C-O duty cycle, or in the first energization of a C-O-C-O duty cycle, during which the specified accuracy has to be maintained
Specified time to accuracy limit in the second fault t''_{al}	time in the second energization of a C-O-C-O duty cycle during which the specified accuracy has to be maintained
Transient dimensioning factor (K_{td})	dimensioning factor to consider the increase of the secondary linked flux due to a d.c. component of the primary short circuit current
Unified specific creepage distance	creepage distance of an insulator divided by the r.m.s. value of the highest operating voltage across the insulator and is expressed in mm/kV

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
ALF	Accuracy Limit Factor
CT	current Transformer
Eal	rated equivalent limiting secondary e.m.f.
E_k	rated knee-point e.m.f.
F	mechanical load
f_R	rated frequency
I_{al}	peak value of the exciting secondary current at E_{al}
I_{dyn}	rated dynamic current
I_e	exciting current
I_{pr}	rated primary current
I_{psc}	rated primary short-circuit current
I_{sr}	rated secondary current
I_{th}	rated short-time thermal current
K_{ssc}	rated symmetrical short-circuit current factor
K_{td}	transient dimensioning factor
R_b	resistive burden
R_{ct}	secondary winding resistance
T	turns
t'	duration of first fault
t''	duration of second fault
t''_{al}	specified time to accuracy limit in the second fault
t'_{al}	specified time to accuracy limit in the first fault
t_{fr}	fault repetition time
T_p	specified primary time constant
U_n	system nominal voltage
$\Delta\phi$	phase displacement
ε	ratio error
ε_c	composite error

2.5 Roles and responsibilities

All Eskom employees and/or appointed bodies involved in the procurement of top core current transformers of nominal voltages from 132kV up to 765kV shall ensure that the product meets the requirements of this standard. Any deviation from these requirements shall constitute a non-conformance, unless if approved in advance by a delegated Eskom current transformer specialist in writing and is based on sound engineering judgement.

All the Contractors supplying current transformers to Eskom must be conversant with the requirements of this standard, and shall comply with the requirements. All the deviations shall be clearly listed in the deviation schedule as part of the tender deliverables. No deviations will be accepted unless approved by Eskom in writing.

The Eskom Instrument Transformer Care Group shall be responsible for ensuring the validity of this document.

2.6 Process for monitoring

This document and its relevance will be evaluated by the relevant instrument transformers Care Group.

2.7 Related/supporting documents

Not applicable.

3. General requirements

Schedule A of the relevant A/B schedules shall form part of this specification and shall take precedence over this standard in case the two documents are conflicting.

3.1 Life expectancy

The life expectancy of current transformers under normal service conditions shall be 25 years.

3.2 Standard service conditions

Unless otherwise specified in schedule A, the following standard conditions shall apply:

a) Ambient temperatures:

1)	Minimum:	-10^{o}C
2)	Maximum:	40^{o}C
3)	Maximum diurnal variation:	35^{o}C
4)	Yearly daily average:	25^{o}C

b) Altitude: Up to 1800m

c) Solar radiation: 2500 kWh/m^{2}

d) Relative humidity: Not exceeding 95% (measured for a period of 24 hours)

e) Wind Pressure: 700 Pa (corresponding to a 34m/s wind speed)

f) Seismic shock: 0.3g

4. Ratings

4.1 General

The common ratings of instrument transformers, including their auxiliary equipment if applicable, should be selected from the following:

a) Highest voltage for equipment (U_m);

b) Rated insulation level;

c) Rated frequency (f_R) and

d) Rated accuracy class

The rating applies at the standardized reference atmosphere (temperature (20°C), pressure (101.3 kPa) and humidity (11 g/m3)) specified in IEC 60071-1.

4.2 Insulation requirements

These requirements shall apply to all types of current transformer insulation. The rated insulation levels for current transformers shall comply with the requirements in Table 1.

Table 1: Rationalized Voltage Ratings

Equipment Nominal Voltage Rating (U_n) (kV)	Highest Voltage for Equipment (U_m) (kV)	Rated Lightning Impulse Withstand Voltage (kV peak) at 1 000 m AMSL)	Rated Power Frequency Withstand Voltage (kV rms) at 1 000 m AMSL)	Rated Switching Withstand Voltage (kV peak) at 1 000 m AMSL)
132	145	650	275	N/A
275	300	1050	460	850
400	420	1425	630	1050
765	800	2100	975	1550

Note: The rated insulation withstand levels for lightning impulse and short time power frequency withstand are specified in Table 1. The service conditions for South Africa are rationalized for altitudes up to 1 800m. Although the insulation levels in Table 1 are specified at an altitude of 0 m to 1 000 m, the values have been selected for appropriate insulation coordination for altitudes up to 1 800 m and need not be corrected for altitude. The CTs should be supplied with standard values as per Table 1 Test values must, however, be corrected for deviations from the standard reference atmospheric conditions.

4.3 Rated primary terminal insulation level

a) Primary terminals shall be of the type and orientation specified in technical schedule A.

b) Primary terminals shall be made Aluminium and shall be specified in technical schedule A. The commonly used terminals for this type of current transformers in Eskom are listed in Table 2.

Table 2: Aluminium terminals for current transformers

Terminal type	Diameter (mm)	Length (mm)
Aluminium Stem	60	125
8 – bolt pad to IEC 60518	-	100 x 200

c) Primary terminals shall be marked P1 and P2 with the following additional requirements:

1) P1 is the terminal which is insulated from the CT head and

2) P2 is the terminal connected to the CT head.

3) The connection between the terminal P2 and CT's head shall be of the same (or of compatible) material as that of the terminals and shall not be of braided construction. It shall be able to carry the rated short circuit current specified in technical schedule A.

Note: The intention of this requirement is to ensure that any flashover from the CT head to earth, or to other phases, will fall within the protected zone of the feeder circuit and will therefore be cleared selectively. To achieve this, the CT is mounted with the P1 terminal (insulated terminal) connected towards (facing) the circuit breaker.

4.4 Other requirements for primary terminals

4.4.1 Partial discharges

a) Partial discharge requirements are applicable to current transformers having $U_m \geq 7.2kV$ and the level shall not exceed limits specified in Table 3.

Table 3: – Partial discharge test voltages and permissible levels

Type of earthing of the neutral system	PD test voltage (r.m.s.) kV	Maximum permissible PD level PC	
		Liquid or gas insulation	Solid insulation
Earthed Neutral	U_m	10	50
	$1.2\ U_m/\sqrt{3}$	5	20
Non effectively earthed	$1.2U_m$	10	50
	$1.2\ U_m/\sqrt{3}$	5	20

4.4.2 Chopped impulse

a) Current transformers shall be capable to withstand a chopped lighting impulse voltage applied to primary terminals having a peak value of 115% of rated lightning impulse withstand voltage.

4.4.3 Capacitance and dielectric dissipation factor

a) A capacitive test tap is required for dielectric dissipation factor (DDF = tangent-delta) testing and should be brought through a separate terminal (for all current transformers having $U_m \geq 24kV$).

b) The special test requirements apply only to current transformers having $U_m \geq 72.2kV$ with liquid immersed primary insulation or gas insulated current transformers with capacitance grading insulation system.

4.4.4 Between-section insulation requirements

a) For interconnected terminal of each section, the rated power frequency withstand voltage of insulation between sections shall be 3kV.

4.4.5 Insulation requirements for secondary terminals

a) The rated power-frequency withstand voltage for secondary terminals insulation shall be 3kV.

b) The rated withstand voltage for inter-turn insulation shall be 4.5 kV peak

4.5 Rated frequency

a) The standard frequency value is 50Hz.

4.6 Rated output

a) Standard values for measuring classes and class P current transformers are: 2.5, 5, 10, 15 and 30VA. The required output shall be specified in technical schedule A.

4.7 Description of standard current transformers used in Eskom

a) Standard current transformers used in Eskom are listed in Annexure A.

4.8 Core and winding design details

4.8.1 Cores, ratios and special characteristics

a) Where multi-ratio CTs are required, the various ratios shall be provided by means of tapping that can be obtained by changing the effective number of turns on the secondary winding.

4.8.1.1 Core Layout

Figures 1 – 3 show the core layouts for Protection (P), Measurements (M) and Bus zone (B). It is important to note the primary terminal polarity markings (i.e. P1, P2) with respect to the core layout.

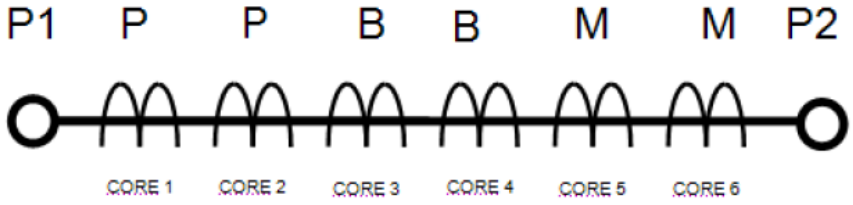

Figure 1: Core Layout – Six Core Current Transformer (2P2M2B)

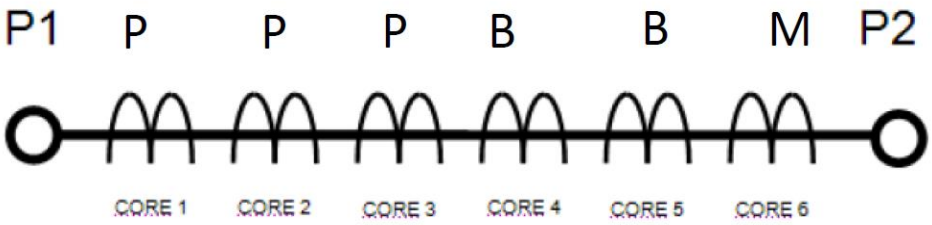

Figure 2: Core Layout – Six Core Current Transformer (3P1M2B)

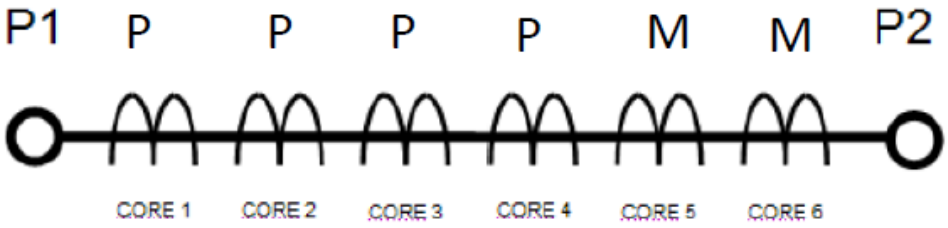

Figure 3: Core Layout – Six Core Current Transformer (4P2M)

4.8.1.2 Tapping arrangements

The secondary core tapping arrangements shall be as indicated in Figure 4 to Figure 6:

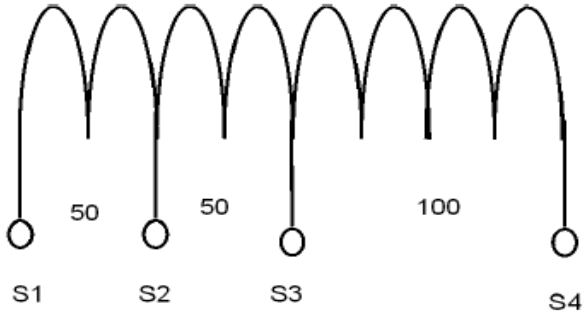

Figure 4: Tapping Arrangements for Multi-ratio 1/200 Measuring Cores

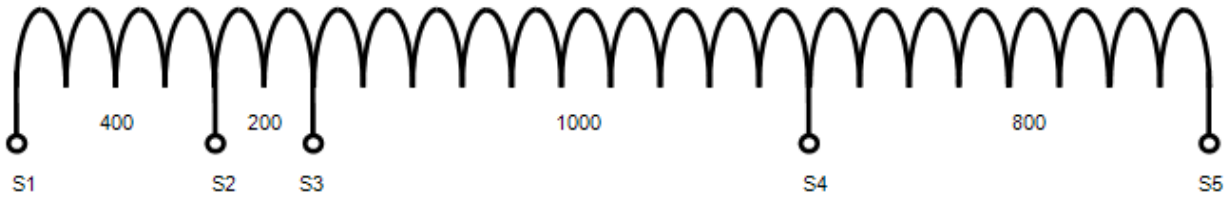

Figure 5: Tapping Arrangements for Multi-ratio 1/2400

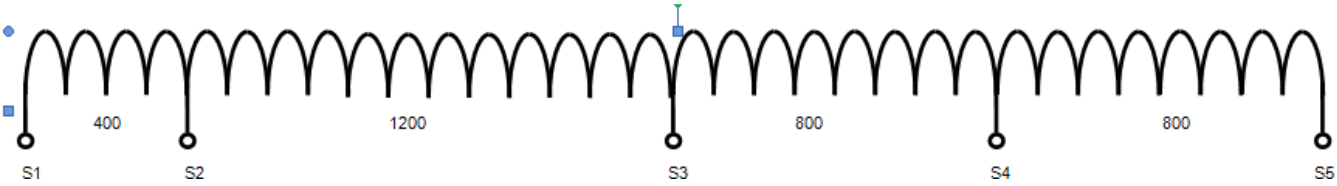

Figure 6: Tapping Arrangements for Multi-ratio 1/3200

4.9 Rated accuracy class

4.9.1 Measuring current transformers

a) For measuring current transformers, the accuracy classes used in Eskom are class 0.2 and in special cases class 0.2S.

b) However Eskom has special requirements for standard measuring current transformers and these are stated in Table 4.

Table 4: Measuring Core Specifications

Maximum Core Ratio	Tapping	Ratio	Class	Burden	Security Factor
MR 1/200	S1 - S2	50/1	0.2	5VA	FS 20
	S3 - S4	100/1		10VA	—
	S1 - S4	200/1		10VA	—
MR 1/2400	S2 - S3	200/1	0.2	2.5VA	—
	S1 - S2	400/1		5VA	FS 20
	S1 - S3	600/1		10VA	—
	S4 - S5	800/1		10VA	—
	S3 - S4	1000/1		10VA	—
	S2 - S4	1200/1		10VA	—

Maximum Core Ratio	Tapping	Ratio	Class	Burden	Security Factor
	S1 - S4	1600/1		10VA	—
	S3 - S5	1800/1		10VA	—
	S2 - S5	2000/1		10VA	—
	S1 - S5	2400/1		10VA	—
MR 1/3200	S1 - S2	400/1	0.2	5VA	FS 20
	S3 - S4	800/1		10VA	—
	S2 - S3	1200/1		10VA	—
	S1 - S3	1600/1		10VA	—
	S2 - S4	2000/1		10VA	—
	S1 - S4	2400/1		10VA	—
	S2 - S5	2800/1		10VA	—
	S1 - S5	3200/1		10VA	—

In cases where Class 0.2S measuring cores are required, the requirements shall be specified in technical schedule A.

4.9.2 Protective current transformers

a) The standard protective current transformers used in Eskom are class PX and class P but there are exceptional cases where TPY is utilized.

4.9.2.1 Class PX Protective Current Transformers

The performance of class PX protective current transformers shall be specified in terms of the following:

a) Rated primary current (I_{pr});

b) Rated secondary current (I_{sr});

c) Rated turns ratio;

d) Rated knee point e.m.f. (E_k);

e) Upper limit of exciting current (I_e) at the rated knee point e.m.f. and

f) Upper limit of the secondary winding resistance (R_{ct}).

4.9.2.2 Class PX protection core specifications

a) Table 5 gives the specifications for class PX protection cores specifications

Table 5: Class PX Protection Core Specifications

Maximum Core Ratio	Tapping	Ratio	Class	E_k min (V)	I_e max (mA)	R_{ct} (Ω) @ 75°C
MR 1/2400	S2 - S3	1/200T	PX	200	504	0.8
	S1 - S2	1/400T		400	252	1.6
	S1 - S3	1/600T		600	168	2.4
	S4 - S5	1/800T		800	126	3.2
	S3 - S4	1/1000T		1000	100	4
	S2 - S4	1/1200T		1200	84	4.8

Maximum Core Ratio	Tapping	Ratio	Class	E_k min (V)	I_e max (mA)	R_{ct} (Ω) @ 75°C
	S1 - S4	1/1600T		1600	63	6.4
	S3 - S5	1/1800T		1800	56	7.2
	S2 - S5	1/2000T		2000	50	8
	S1 - S5	1/2400T		2400	42	9.6
MR 1/3200	S1 - S2	1/400T	PX	400	256	1.6
	S3 - S4	1/800T		800	128	3.2
	S2 - S3	1/1200T		1200	85	4.8
	S1 - S3	1/1600T		1600	64	6.4
	S2 - S4	1/2000T		2000	51	8.0
	S1 - S4	1/2400T		2400	42	9.6
	S2 - S5	1/2800T		2800	36	11.2
	S1 - S5	1/3200T		3200	32	12.8

4.9.2.3 Class PX buszone protection core specifications

Table 6 give the specifications for class PX buszone protection cores specifications.

Table 6: Buszone Core Specifications

Maximum Core Ratio	Tapping	Ratio	Class	E_k min (V)	I_e max (mA)	R_{ct} (Ω) @ 75°C
FR 1/500	S1 - S2	1/500T	PX	550	50	2
FR 1/1200	S1 - S2	1/1200T	PX	550	50	2
FR 1/1600	S1 - S2	1/600T	PX	550	50	2
MR 1/1600/1200/1000	S1 - S2	1/1000T	PX	550	50	2
	S1 - S3	1/1200T		660	42	2.4
	S1 - S4	1/1600T		880	31	3.2
MR 1/1600/1200	S1 – S2	1/1200T	PX	550	50	2
	S1 – S3	1/1600T		733	38	2.7
MR 1/2400/1600	S1 – S2	1/1600T	PX	550	50	2
	S1 – S3	1/2400T		825	33	3
FR 1/2400	S1 - S2	1/2400	PX	550	50	2

Note: The CT's name plate shall reflect the manufacturer's design values for the core excitation current, i.e. rather than the maximum allowable values specified above.

4.9.2.4 Class P protective current transformers

a) The standard accuracy limit factor (ALF) values are 5, 10, 15, 20 and 30.

b) The accuracy class is designated using the highest permissible percentage of the composite error, followed by the letter "P" (standing for "protection") and the *ALF* value.

c) The standard accuracy classes for protective current transformers are 5P and 10P.

d) At rated frequency and with rated burden connected, the ratio error, phase displacement and composite error shall not exceed the limits given in Table 7.

Table 7: Error limits for class P current transformers

Accuracy class	Ratio error at rated primary current ± %	phase displacement at rated primary current		Composite error at rated accuracy limit primary current %
		± Minutes	± Centiradians	
5P	1	60	1.8	5
10P	3	—	—	10

Note: Class P protection current transformers are non-standard and will be specified in technical schedule A when required.

4.9.2.5 Class P unbalance current transformers

Table 8 give the specifications for class P protection cores specifications.

Table 8: Unbalance CT Core specifications

Maximum Core Ratio	Tapping	Ratio	Class	ALF	Burden
1/1	S1 - S2	1/1	5P	10	10VA
1/2	S1 - S2	1/2	5P	10	10VA
1/5	S1 - S2	1/5	5P	10	10VA
1/10	S1 - S2	1/10	5P	10	10VA
1/20	S1 - S2	1/20	5P	10	10VA

4.9.2.6 Class TPY protective current transformers

a) The error limits for class TPY current transformer at the rated frequency and burden are given in Table 9.

Table 9: Error limits for TPY current transformers

Class	At rated primary current			Transient error limits under specified duty cycle conditions
	Ratio error ±%	Phase displacement		
		minutes	Centiradians	
TPY	1.0	±60	±1.8	ε = 10%

b) The performance of class TPY protective current transformers shall be specified in terms of the following:

1) Class designation (i.e. TPY),

2) Rated symmetrical short circuit current factor (Kssc),

3) Duty cycle consisting of C-O-CO cycle: t'_{al}, t', t_{fr} and t''_{al},

4) Rated primary time constant (T_p)

5) Rated resistive burden (R_b)

Note: For current transformers with tapped secondary windings, the given accuracy requirements can be fulfilled with only one ratio.

4.10 Standard values of rated primary current

a) The standard values for rated primary current for top current transformers used in Eskom are 2A, 4A, 10A, 20A, 40A, 200A, 2500A, 3150A and 4000A.

b) Should a non-standard rated primary current for a current transformer be required, it shall be stated in technical schedule A.

4.11 Standard values of rated secondary current

a) The standard value for rated secondary current for current transformers used in Eskom is 1A.

4.12 Short-time current rating (I_{th})

a) The standard values for short-time current (I_{th}) for top current transformers used in Eskom are 0.6kA, 10kA, 40kA, 50kA and 63kA

4.13 Rated dynamic current (I_{dyn})

a) The standard value of the rated dynamic current (I_{dyn}) is 2.5 times the rated short-time thermal current (I_{th}).

5. Design and construction

5.1 Requirements for liquids used in equipment

5.1.1 General

a) The manufacturer shall specify the type and the required quantity and quality of the liquid to be used in the equipment in schedule B.

b) Facilities for oil filling and draining shall be provided. These facilities shall be suitably sealed below the normal operating oil level and shall not leak oil when the transformer is tested.

c) The method used to allow for the expansion of the insulating oil shall be stainless steel bellows.

d) If so specified in schedule A, oil sample valves shall be provided. Details of the oil sample valves shall be submitted for approval before manufacturing is undertaken.

5.1.2 Liquid quality

For oil-filled equipment, insulating oil shall comply with IEC 60296.

5.1.3 Liquid level device

The device for checking the liquid level shall indicate whether the liquid level is within the operating range, during operation.

5.1.4 Liquid tightness

a) No liquid loss is permitted (i.e. current transformers shall be hermetically sealed). Any liquid loss represents a danger of insulation contamination.

b) Details of the sealing arrangement shall be submitted for approval if requested in schedule A.

c) Where the manufacturer's design requires specially designed gasketted joints to be above the oil level, machined surfaces and O-rings shall be used. Details of such joints shall be submitted for approval if requested in schedule A.

5.2 Requirements for gases used in equipment

5.2.1 General

a) The manufacturer shall specify the type and the required quantity and quality of the gas to be in equipment.

5.2.2 Gas quality

a) New SF_6 (sulphur hexafluoride) shall comply with IEC 60376.

b) New green (g^3) gases shall comply with their respective standards.

c) The maximum allowed moisture content within instrument transformers filled with gas at rated filling density for insulation shall be such that the dew-point is not higher than – 5 °C for a measurement at 20 °C.

d) Adequate correction shall be applied for measurement at other temperatures. For the measurement and determination of the dew point, refer to IEC 60376 and IEC 60480.

5.2.3 Gas monitoring device

a) Gas-insulated instrument transformers having a minimum functional pressure above 0.2 MPa shall be provided with pressure or density monitoring device.

b) Gas monitoring devices may be provided alone or together with the associated equipment.

5.2.4 Gas tightness

a) The tightness characteristic of a closed pressure system stated by the manufacturer shall be consistent with a minimum maintenance and inspection philosophy.

b) The tightness of closed pressure systems for gas is specified by the relative leakage rate F_{rel} of each compartment.

c) Standardized leakage rate value is 0.5 % per year, for SF_6 and SF_6-mixtures.

d) The standardized leakage rate value should be less or equal to 0.5% for new green (g^3) gases.

e) Means shall be provided to enable gas systems to be safely replenished whilst the equipment is in service.

f) An increased leakage rate at extreme temperatures is acceptable, provided that this rate resets to a value not higher than the maximum permissible value at normal ambient air temperature. The increased temporary leakage rate shall not exceed the values given in Table 10.

Table 10: Permissible temporary leakage rate for gas systems

Temperature Class (^oC)	Permissible temporary leakage rate
+40	$3F_p$
Ambient temperature	F_p
-10	$3F_p$

5.2.5 Pressure relief device

a) Gas insulated current transformers shall be provided with a pressure relief device.

b) The device shall be protected against any accidental damage.

5.3 Requirements for solid materials used in equipment

a) Specifications for organic material used for instrument transformers (i.e. epoxy resin, polyurethane resin, epoxy-cycloaliphatic resin, composite material, etc.) either for indoor or outdoor installations are given in the IEC 60455 series.

b) Dry type CTs shall have resin-encapsulated cores and windings.

5.4 Requirements for temperature rise

5.4.1 General

a) The temperature rise in a current transformer when carrying a primary current equal to the rated continuous thermal current, with a unity power-factor and burden corresponding to the rated output, shall not exceed the appropriate value given in Table 11, when operating under service conditions specified in paragraph 3.2.

Table 11: limits for temperature rise

Part of instrument transformers	Temperature-rise limit K
1. Oil-immersed instrument transformers	
– top oil	50
– top oil, hermetically sealed	55
– winding average	60
– winding average, hermetically sealed	65
– other metallic parts in contact with oil	as for winding
2. Solid or gas insulated instrument transformers	
– winding (average) in contact with insulating materials of the following classes[a]:	
• Y	45
• A	60
• E	75
• B	85
• F	110
• H	135
– other metallic parts in contact with the above insulating material classes	as for windings
3. Connection, bolted or the equivalent	
– Bare-copper, bare-copper alloy or bare-aluminium alloy	
• in air	50
• in SF_6	75
• in oil	60
– Silver-coated or nickel-coated	
• in air	75
• in SF_6	75
• in oil	60
– Tin-coated	
• in air	65
• in SF_6	65
• in oil	60

[a] Insulating class definitions according to IEC 60085.

5.4.2 Influence of altitude on temperature

If a current transformer is specified for service at an altitude in excess of 1 000m and tested at an altitude below 1 000m, the limits of temperature rise ΔT given in Table 11 shall be reduced by the following amounts for each 100m that the altitude at the operating site exceeds 1 000 m:

a) Oil-immersed current transformers: 0.4% and

b) Dry-type and gas insulated current transformers: 0.5%.

5.5 Requirements for earthing

a) The frame of current transformers shall be provided with a reliable earthing terminal for connection to an earthing conductor suitable for specified fault conditions.

b) The connecting point shall be marked with the “earth” symbol as indicated by symbol number 5019 of IEC 60417.

5.5.1 Electrical continuity

a) The continuity of the earthing circuits shall be ensured taking into account the thermal and electrical stresses caused by the current they may have to carry.

b) For the interconnection of enclosures, frames, etc., fastening (e.g. bolting or welding) is acceptable for providing electrical continuity.

5.6 Requirements for external insulation

a) For outdoor current transformers with ceramic (porcelain) or composite insulators susceptible to contamination, the creepage distance of 25mm/kV and 31mm/kV shall be used.

NB: Ratio of the creepage distance between phase and earth over the r.m.s. phase-to-phase value of the highest voltage for the equipment (see IEC 60071-1). For further information and manufacturing tolerances on the creepage distance, see IEC 60815.

5.7 Mechanical requirements

a) The requirements apply to current transformers rated for highest voltage of 72.5kV and above. Current transformers must be able to withstand static loads given in Table 12 applied in any direction to the primary terminals.

Table 12: Static withstand test loads

Highest Voltage for Equipment Um kV	Static withstand test load FR N	
	Load Class 1	Load Class 2
123 - 170	2000	3000
245 - 362	2500	4000
≥ 420	4000	5000

5.8 Internal arc fault protection

a) The requirements apply to oil immersed and gas insulated free-standing current transformers with U_m ≥ 72.5kV for which arc fault protection is additionally specified.

b) If the requirements are specified, the current transformer must be able to withstand internal arc of the specified current and duration specified in Table 13.

Table 13: Arc fault duration and protection criteria

Internal arc fault current r.m.s. value kA	Protection stage	Arc fault duration s	Internal arc fault protection class I	Internal arc fault protection class II
<40	1	0.2	Fracture of housing and fire permitted, but all projected part to be within the containment area	No external effect other than the operation of pressure relief device
	2	0.5		No fragmentation (burn-through or fire acceptable)
≥40	1	0.1		No external effect other than the operation of pressure relief device
	2	0.3		No fragmentation (burn-through or fire acceptable)

NB: This test is not a guarantee against containment under all short-circuit conditions, but a test to demonstrate conformance to an agreed level of safety.

c) If required in schedule A, the CTs' construction shall comply with the fail-safe design, yielding a low explosion risk. The supplier is to provide details of the fail-safe design features in the tender.

5.9 Degrees of protection by enclosures

a) The recommended minimum degree of protection for low-voltage control and/or auxiliary enclosures for outdoor current transformers is IP56.

5.10 Electromagnetic compatibility

5.10.1 Requirement for Radio Interference Voltage (RIV)

a) The requirement applies to current transformers having $U_m \geq 123$kV to be installed in air-insulated substations. The radio interference voltage shall not exceed 2 500µV at $1.1U_m/\sqrt{3}$.

5.10.2 Requirement for transmitted overvoltages

a) These requirements apply to instruments transformers having $U_m \geq 72.5$ kV. The overvoltages transmitted from the primary to the secondary terminals shall not exceed the values given in Table 14.

Table 14: Transmitted overvoltage limits

Type of impulse	Air insulated current transformers
Peak value of applied voltage (U_p)	$1.6 * \frac{\sqrt{2}}{\sqrt{3}} * U_m$
Waveshape characteristics conventional front time (T_1) time to half (T_2)	 0.5µs ± 20% ≥ 50µs
Transmitted overvoltage peak limits (U_s)	1.6kV

6. Construction

6.1 Secondary terminals

a) The secondary terminals shall be rail-mounted, and shall be the spring-loaded screw clamp type of 10 mm width in accordance with IEC 60947-7-1. The terminals shall accept two back-to-back hook blade lugs.

6.2 Secondary terminal boxes

a) Each CT shall be fitted with a secondary terminal box that shall be located in an accessible position and shall be provided with an easily removable (preferably slip-on) weather-proof cover. When in place, the cover shall be secured to the corresponding terminal box by means of a minimum M8 stainless steel set screw or an otherwise approved method.

b) The type of terminal box shall be stated in schedule B and, subject to approval, shall be either:

c) Integrally cast with the CT case;

d) The terminal box with the cover fixed in place shall have a degree of protection of at least IP56 in accordance with IEC 60529.

e) The secondary terminal box shall have an opening, at the bottom of the box, for vertical entry of the secondary control cables. The opening shall be covered externally by an undrilled, removable gland plate of brass (of minimum thickness 2mm), aluminium alloy (of minimum thickness 3mm) or stainless steel (of minimum thickness 2mm) for a steel or aluminium box. Unless otherwise specified in schedule A, this gland plate and the opening shall have an effective area of at least 75mm × 50mm. This area shall be stated in schedule B. Access to the gland-plate opening shall not be obstructed for cables that enter the terminal box vertically from below.

f) The distance between the bottom terminals and the gland plate shall be at least 75 mm.

g) The terminal box shall be fitted with a breathing vent of diameter at least 10 mm. This vent shall be situated in the bottom of the box, shall be made of non-corroding material and shall be designed to prevent the entry of insects.

h) The beginning and the end of each secondary winding with all secondary taps, if any, shall be wired to suitable terminals accommodated in the terminal box.

i) An earth terminal shall be provided for earthing of the secondary windings inside the terminal box and shall have an external connection to the main earthing system.

6.3 Capacitive test tap

a) The capacitive tap connection shall be provided for dielectric dissipation factor (tan delta) testing purposes. This terminal shall be clearly labelled.

6.4 Current transformer base

a) The base shall have an earthing flag of 5 mm × 50 mm × 100 mm (minimum), with two 14 mm holes at 50 mm centres arranged vertically. The flag shall be situated in close proximity to mounting bolt hole on the same side as the terminal box.

6.5 Hollow core insulators

a) Insulators shall comply with IEC 60815-2 and IEC 61462.

b) The name of the manufacturer and the country of origin of the HV insulators shall be stated in schedule B, and detailed drawings of the insulator shall be supplied with the tender. Permission shall be obtained from the purchaser before a change of insulator supplier during the course of a contract.

6.6 Mounting arrangement

a) The base mounting arrangement for the CTs shall be such that it can be bolted to a support structure, with mounting holes arranged on the corners of a square of dimensions not exceeding those specified in schedule A.

6.7 Corrosion

Unless otherwise approved, all ferrous parts associated with current transformers shall either be:

a) Hot-dip galvanized in accordance with SANS 121, of minimum coating thickness not less than 90µm; or

b) Zinc metal sprayed in accordance with SANS 2063, of minimum coating thickness not less than 80µm.

Metallization shall be followed by a base coat and top coat in accordance with SANS 12944-5. Metallization shall be followed by a base coat and top coat in accordance with SANS 12944-5.

All materials shall be inherently corrosion-resistant or treated against corrosion for the design lifetime of the equipment.

6.8 Markings

6.8.1 Terminal Markings

The terminal markings shall identify:

a) The primary and secondary windings,

b) The winding sections, if any,

c) The relative polarities of windings and winding sections and

d) The intermediate taps, if any.

NB: Further clarity on terminal markings is provided in Table 208 of IEC 61869-2.

6.9 Rating and diagram plates

The plate(s) shall be mechanically affixed e.g. screwed or riveted, to the equipment. Mounting by means of adhesives is not acceptable.

The plate(s) shall be manufactured from anodized aluminium or stainless steel and the material, and the method of mounting the plates, shall be stated in technical schedule B.

The plate(s) shall be externally fixed on a vertical surface of the main body of the CT, in close proximity to the terminal box and not to any removable part. The size of the characters shall be not less than 4mm.

The following information shall be engraved or stamped into the rating plate:

1) Manufacturer’s name

2) Year of manufacture, serial number and type designation

3) Rated primary and secondary current

4) The rated continuous thermal current if it is different from the rated primary current.

5) Rated short-time thermal current (I_{th})

6) Rated dynamic current (I_{dyn})

7) Rated frequency

8) Highest voltage of equipment

9) Rated insulation level

10) Mass in kg

11) Class of mechanical requirements (for $U_m \geq 72kV$)

12) On current transformers with two or more secondary windings, the use of each winding and its corresponding terminals

NB: Some items can be combined e.g. 145/275/650kV

6.10 Warranty

Eskom only accepts current transformers with a minimum warranty of 5 years.

7. Tests

7.1 General

7.1.1 Classification of tests

The tests specified in this standard are classified as follows:

a) Type test: a test made on equipment to demonstrate that all equipment made to the same specification complies with the requirements not covered by routine tests.

b) Routine test: a test to which each individual piece of equipment is subjected. Routine tests are for the purpose of revealing manufacturing defects. They do not impair the properties and reliability of the test object.

c) Special test: a test other than a type test or a routine test, agreed on by manufacturer and Eskom.

7.2 Type tests

Unless valid and approved type test certificates specified in IEC 61869-1, IEC 61869-2 and in Schedule A are available, type tests must be carried out on one fully assembled current transformer of each type and rating at an IEC approved test facility. The certificates of the tests shall be included in the test reports. Type tests shall be followed by routine tests. Type tests are listed in (a) to (k):

a) Short-time current test

b) Temperature rise test

c) Lightning impulse test on primary terminals

d) Switching impulse voltage test (for current transformers with $U_m \geq 300kV$)

e) Wet test for outdoor type transformers (for current transformers with $U_m < 300kV$)

f) Radio interference voltage (for current transformers with $U_m \geq 123kV$)

g) Transmitted overvoltage test (for current transformers with $U_m \geq 72.5kV$)

h) Test for accuracy

i) Verification of the degree of protection by enclosures

j) Enclosure tightness test at ambient temperature (for gas insulated current transformers)

k) Pressure test for enclosure (for gas insulated current transformers)

7.3 Routine tests

7.3.1 General

Each fully assembled current transformer shall be subjected to the routine tests mentioned below at the manufacturer's works to prove compliance to this specification.

a) Verification of terminal markings

b) Power-frequency withstand test on primary winding

c) Partial discharge measurement

d) Power-frequency withstand test on secondary terminals

e) Power-frequency withstand tests between sections

f) Test for accuracy

g) Enclosure tightness test at ambient temperature (for gas insulated current transformers)

h) Pressure test for enclosure (for gas insulated current transformers)

i) Determination of the secondary winding resistance

j) Test for rated knee point e.m.f. and exciting current at rated knee point e.m.f.

k) Inter-turn overvoltage test

7.3.2 Capacitance and dielectric dissipation factor (tan delta) tests

7.3.2.1 General

The main purpose is to check the uniformity of the production. Conduct this test after the power-frequency withstand test; this test is applicable to all oil-immersed paper-insulated current transformers with *U*m ≥ 24 kV. Record the tangent delta and the capacitance (*C*) readings at 10 kV on the information plate mounted on the tank for the purposes of condition monitoring.

7.3.2.2 Current Transformers with Um ≥ 52kV

Raise the voltage applied between primary terminals bonded together and the earth screen terminal to 120% of U_m /√3. While the voltage is being raised, record the tangent delta measurements at voltages of 10kV, 66.6%, 100%, and 120% of U_m /√3. Thereafter, take the measurements in the reverse order back to 10kV, i.e. 100%, 66.6% and 10kV.

The current transformer is deemed to have passed the test when it meets the following two conditions:

a) The absolute value of tangent delta readings at each step, during both excursions, is not more than 0.5% (i.e. 0.005) and

b) The difference in absolute value between the readings at the maximum test voltage (120% of U_m /√3) and that at the minimum test voltage (10kV) is not more than 0,001.

7.4 Special tests

When specified in schedule A, special tests shall be performed and may be specified as type tests. The following special tests which are listed and described in detail in IEC 61869-1 and IEC 61869-2 are required by Eskom:

a) Chopped impulse voltage withstand test on primary windings

b) Capacitance and dielectric dissipation factor (tan delta) tests

c) Mechanical tests (applicable to current transformers with U_m ≥ 72.5kV)

d) Internal arc fault test (applicable to current transformers with U_m ≥ 72.5kV)

e) Corrosion test

7.4.1 Mechanical tests

When the mechanical tests on primary terminals are specified in schedule A, the applied design factor of safety shall be at least 2.

7.5 Test certificates (Routine tests certificates)

a) Each CT shall be delivered with one copy of all routine test certificates together with a copy of the excitation curve showing clearly where the knee-point occurs for each protective core and, in the case of multi-ratio windings, stating to which ratio the curve applies.

b) These certificates and curves shall be packed in a waterproof container and housed inside the terminal box of each respective current transformer.

c) All tests shall be fully documented in English, signed by the relevant (competent) manufacturer's personnel and stamped.

d) Electronic copies must be stored by the manufacturer for a period not less than 10 years and be made available to Eskom upon request.

7.6 Works inspections and witnessing of tests

a) Eskom reserves the right to appoint a representative to inspect the current transformers at any stage of manufacture, or to be present at any of the tests specified.

8. Marking, labelling and packaging

a) The marking, labelling and packaging details are to be submitted to Eskom for approval prior to manufacturing.

b) Imported CTs shall be packaged in robust wooden crates and suitably supported in order to protect the CT from the stresses of normal handling that can be expected from the point of despatch to the point of construction.

c) Crates must be designed such that inspection can be effected without opening or damaging the crate. The crate must be able to be lifted by slings with lifting points clearly marked. Any special handling requirements shall be clearly specified to purchaser before delivery and shall be clearly specified on packaging.

d) Packaging shall not disintegrate due to exposure to rain and direct sunlight during outdoor storage and the construction period of 18 months in total. The manufacturer/supplier shall notify the purchaser of any special methods recommended for storage prior to delivery, and on packaging materials.

e) If CTs are packed in crates on pallets, the gross weight of the pallets shall not exceed 1 800 kg. Pallets shall be suitable for handling by forklift trucks, capable of entry from both sides. All boxes, pallets or containers shall be clearly marked in accordance with the following example, or similar approved template:

1) Eskom Order No.:
2) Eskom SAP No.:
3) Project Name:
4) Project Number:
5) Delivery Address:
6) Supplier's Name:
7) Supplier's Serial No.

8) Technical Description of current transformers

9) Gross Weight:

8.1 User manual

a) The manufacturer must provide Eskom with an electronic user manual in pdf format specifying the following details:

1) Packaging,

2) Handling (correct handling and slinging methods),

3) Transportation,

4) Installation,

5) Storage (short and long terms) and

6) Maintenance

9. Documentation

9.1 Tender documentation

a) The following technical information and drawings shall be submitted as part of the tender:

1) Completed technical schedule,

2) Technical deviation sheet (in case there are deviations)

3) Current transformer outline drawing,

4) Detailed drawing of the insulator

5) Instruction / user manual

6) Type test reports

Unless otherwise specified in schedule A, one hard copy and one digital copy of all documentation pertaining to the equipment offered shall be supplied. The digital copy shall be shall be compatible with “Adobe Acrobat pdf” format. All information shall be in English.

9.2 Contract documentation after tender award

a) The following drawings and technical information shall be submitted for final approval after the contract is awarded but before manufacturing can commence:

1) Outline drawing

2) Terminal box drawing internal

3) Detailed drawing of the rating plate

4) Scheme diagram

5) Section drawing

6) Instruction / user manual

7) Typical routine test sheet

10. Drawings

10.1 Details of drawings

10.1.1 Outline drawing

A outline drawing that shows the following minimum information shall be provided for each type of CT such that the physical arrangement can be correlated with the electrical schematic arrangement:

a) Nominal voltage, normal current, short-circuit withstand current and durations in the title block,

b) The type of insulating material,

c) Mounting details,

d) Primary terminal dimensions and markings,

e) Overall dimensions,

f) The position of the earthing terminal,

g) The height of the gland plate in the secondary terminal box above the base, and the distance of the terminal box centre-line from the centre-line of the CT,

h) The total creepage and the arcing distance of the hollow core insulator; and

i) The mass of the complete CT and the volume of the oil

j) Allowance for the inclusion of:

   1) Eskom SAP number; and

   2) Eskom drawing number

Note: The numbers shall be incorporated in the drawing upon issue.

10.1.2 Section drawing

A sectional arrangement drawing, which depicts the following details, shall be supplied:

a) The relative position of the core and windings,

b) The hollow core insulator,

c) Oil-sealing arrangement,

d) The method used to accommodate expansion of the oil and

e) Pressure-relief device, where applicable

10.1.3 Insulator drawing

A detailed drawing of the insulator showing all important dimensions shall be provided.

10.1.4 Terminal box

A detailed drawing of the terminal box showing the following:

a) Method of affixing the cover,

b) Position and dimensions of the gland plate

c) Arrangement and clearances of the secondary terminals, creepage extension barriers, if applicable, and markings; and

d) Breathing arrangement

11. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Sibongile Maphosa	Engineer (TX AME – Substation Equipment & Diagnostics)
Bheki Ntshangase	Senior Manager (TX AME – Substation Equipment & Diagnostics)

12. Revisions

Date	Rev	Compiler	Remarks
Nov 2021	2	S Maphosa	• Changed protective and measurement CTs technical parameters. • Included requirements for new (g^3) gases
Aug 2021	1	S Maphosa	New document

13. Development team

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14. Acknowledgements

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Annex A – Current Transformers List

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
132kV Porcelain Current Transformers					
180031	CT 132kV 2500A 40kA 2P 2M 2B5 31mm/kV	PPBBMM	1/2400T MR	1/500T FR	2400/1 MR
180034	CT 132kV 2500A 40kA 2P 2M 2B16-12-10 31mm/kV	PPBBMM	1/2400T MR	1/1600T MR	2400/1 MR
257374	CT 132kV 2500A 40kA 2P 2M 2B24 31mm/kV	PPBBMM	1/2400T MR	1/2400T FR	2400/1 MR
216835	CT 132kV 2500A 40kA 3P 1M 2B24 31mm/kV	PPPBBM	1/2400T MR	1/2400T FR	2400/1 MR
243900	CT 132kV 2500A 40kA 2P 2M 2B16 31mm/kV	PPBBMM	1/2400T MR	1/1600T FR	2400/1 MR
217028	CT 132kV 2500A 40kA 3P 1M 2B16 31mm/kV	PPPBBM	1/2400T MR	1/1600T FR	2400/1 MR
243902	CT 132kV 2500A 40kA 2P 2M 2B12 31mm/kV	PPBBMM	1/2400T MR	1/1200T FR	2400/1 MR
630597	CT 132kV 2500A 40kA 3P 1M 2B12 31mm/kV	PPPBBM	1/2400T MR	1/1200T FR	2400/1 MR
675463	CT 132kV 3150A 40kA 2P 2M 2B24031mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
275kV Porcelain Current Transformers					
639033	CT 275kV 3150A 50KA 2P 2M 2B24 25mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
639037	CT 275kV 3150A 50KA 3P 1M32 2B24 25mm/kV	PPPBBM	1/3200T MR	1/2400T FR	3200/1 MR
639038	CT 275kV 3150A 50KA 2P 2M32 2B16 25mm/kV	PPBBMM	1/3200T MR	1/1600T FR	3200/1 MR
639039	CT 275kV 3150A 50KA 3P 1M32 2B16 25mm/kV	PPPBBM	1/3200T MR	1/1600T FR	3200/1 MR
639040	CT 275kV 3150A 50KA 2P 2M32 2B12 25mm/kV	PPBBMM	1/3200T MR	1/1200T FR	3200/1 MR
639041	CT 275kV 3150A 50KA 3P 1M32 2B12	PPPBBM	1/3200T MR	1/1200T FR	3200/1 MR

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
	25mm/kV				
639042	CT 275kV 3150A 50KA 2P 2M32 2B24-16 25mm/kV	PPBBMM	1/3200T MR	1/2400T MT	3200/1 MR
639043	CT 275kV 3150A 50KA 3P 1M32 2B24-16 25mm/kV	PPPBBM	1/3200T MR	1/2400T MT	3200/1 MR
639044	CT 275kV 3150A 50KA 2P 2M32 2B16-12 25mm/kV	PPBBMM	1/3200T MR	1/1600T MR	3200/1 MR
639045	CT 275kV 3150A 50KA 3P 1M32 2B16-12 25mm/kV	PPPBBM	1/3200T MR	1/1600T MR	3200/1 MR
639032	CT 275kV 3150A 50KA 2P 2M32 2B24 31mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
8575	CT 275kV 3150A 50KA 3P 1M32 2B24 31mm/kV	PPPBBM	1/3200T MR	1/2400T FR	3200/1 MR
186669	CT 275kV 3150A 50KA 2P 2M32 2B16 31mm/kV	PPBBMM	1/3200T MR	1/1600T FR	3200/1 MR
186670	CT 275kV 3150A 50kA 3P 1M32 2B16 31mm/kV	PPPBBM	1/3200T MR	1/1600T FR	3200/1 MR
639064	CT 275kV 3150A 50KA 2P 2M32 2B12 31mm/kV	PPBBMM	1/3200T MR	1/1200T FR	3200/1 MR
639065	CT 275kV 3150A 50KA 3P 1M32 2B12 31mm/kV	PPPBBM	1/3200T MR	1/1200T FR	3200/1 MR
639066	CT 275kV 3150A 50KA 2P 2M32 2B24-16 31mm/kV	PPBBMM	1/3200T MR	1/2400T MT	3200/1 MR
639067	CT 275kV 3150A 50KA 3P 1M32 2B24-16 31mm/kV	PPPBBM	1/3200T MR	1/2400T MT	3200/1 MR

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
639068	CT 275kV 3150A 50KA 2P 2M32 2B16-12 31mm/kV	PPBBMM	1/3200T MR	1/1600T MR	3200/1 MR
639069	CT 275kV 3150A 50KA 3P 1M32 2B16-12 31mm/kV	PPPBBM	1/3200T MR	1/1600T MR	3200/1 MR
639046	CT 275kV 2500A 50KA 2P 2M24 2B24 25mm/kV	PPBBMM	1/2400T MR	1/2400T FR	1/2400 MR
639047	CT 275kV 2500A 50KA 3P 1M24 2B24 25mm/kV	PPPBBM	1/2400T MR	1/2400T FR	1/2400 MR
639048	CT 275kV 2500A 50KA 2P 2M24 2B16 25mm/kV	PPBBMM	1/2400T MR	1/1600T FR	1/2400 MR
639049	CT 275kV 2500A 50KA 3P 1M24 2B16 25mm/kV	PPPBBM	1/2400T MR	1/1600T FR	1/2400 MR
639050	CT 275kV 2500A 50KA 2P 2M24 2B12 25mm/kV	PPBBMM	1/2400T MR	1/1200T FR	1/2400 MR
639051	CT 275kV 2500A 50KA 3P 1M24 2B12 25mm/kV	PPPBBM	1/2400T MR	1/1200T FR	1/2400 MR
639052	CT 275kV 2500A 50KA 2P 2M24 2B24-16 25mm/kV	PPBBMM	1/2400T MR	1/2400T MR	1/2400 MR
639053	CT 275kV 2500A 50KA 3P 1M24 2B24-16 25mm/kV	PPPBBM	1/2400T MR	1/2400T MR	1/2400 MR
639054	CT 275kV 2500A 50KA 2P 2M24 2B16-12 25mm/kV	PPBBMM	1/2400T MR	1/1600T MR	1/2400 MR
639055	CT 275kV 2500A 50KA 3P 1M24 2B16-12 25mm/kV	PPPBBM	1/2400T MR	1/1600T MR	1/2400 MR
639056	CT 275kV 2500A 50KA 2P 2M24 2B24 31mm/kV	PPBBMM	1/2400T MR	1/2400T FR	1/2400 MR

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
639057	CT 275kV 2500A 50KA 3P 1M24 2B24 31mm/kV	PPPBBM	1/2400T MR	1/2400T FR	2400/1 MR
186671	CT 275kV 2500A 50kA 2P 2M24 2B16 31mm/kV	PPBBMM	1/2400T MR	1/1600T FR	2400/1 MR
639058	CT 275kV 2500A 50KA 3P 1M24 2B16 31mm/kV	PPPBBM	1/2400T MR	1/1600T FR	2400/1 MR
186673	CT 275kV 2500A 50kA 2P 2M24 2B12 31mm/kV	PPBBMM	1/2400T MR	1/1200T FR	2400/1 MR
186674	CT 275kV 2500A 50kA 3P 1M24 2B12 31mm/kV	PPPBBM	1/2400T MR	1/1200T FR	2400/1 MR
186667	CT 275kV 2500A 50kA 2P 2M24 2B5 31mm/kV	PPBBMM	1/2400T MR	1/500T FR	2400/1 MR
639059	CT 275kV 2500A 50KA 2P 2M24 2B24-16 31mm/kV	PPBBMM	1/2400T MR	1/2400T MR	2400/1 MR
639060	CT 275kV 2500A 50KA 3P 1M24 2B24-16 31mm/kV	PPPBBM	1/2400T MR	1/2400T MR	2400/1 MR
639061	CT 275kV 2500A 50KA 2P 2M24 2B16-12 31mm/kV	PPBBMM	1/2400T MR	1/1600T MR	2400/1 MR
639062	CT 275kV 2500A 50KA 3P 1M24 2B16-12 31mm/kV	PPPBBM	1/2400T MR	1/1600T MR	2400/1 MR
640324	CT 275kV 3150A 50kA 4P2M 25mm/kV	PPPPMM	1/3200T MR	—	3200/1 MR
640325	CT 275kV 3150A 50kA 4P2M 31mm/kV	PPPPMM	1/3200T MR	—	3200/1 MR
640326	CT 275kV 200A 10kA 2M 31mm/kV	2M	—	—	200/1 MR
275kV Composite Current Transformers					
639609	CT 275kV 3150A 50kA 2P 2M 2B24 31mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
639612	CT 275kV 3150A 50kA 3P 1M 2B24 31mm/kV	PPPBBM	1/3200T MR	1/2400T FR	3200/1 MR
639610	CT 275kV 3150A 50kA 2P2M2B24-16 31mm/kV	PPBBMM	1/3200T MR	1/2400T MR	3200/1 MR
639613	CT 275kV 3150A 50kA 3P1M2B24-16 31mm/kV	PPPBBM	1/3200T MR	1/2400T MR	3200/1 MR
639611	CT 275kV 3150A 50kA 2P2M2B16-12 31mm/kV	PPBBMM	1/3200T MR	1/1600T MR	3200/1 MR
639614	CT 275kV 3150A 50kA 3P1M2B16-12 31mm/kV	PPPBBM	1/3200T MR	1/1600T MR	3200/1 MR
400kV Porcelain Current Transformers					
639164	CT 400kV 4000A 63KA 2P 2M B24 25mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
639070	CT 400kV 3150A 50KA 2P 2M 2B24 25mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
639071	CT 400kV 3150A 50KA 3P 1M32 2B24 25mm/kV	PPPBBM	1/3200T MR	1/2400T FR	3200/1 MR
639072	CT 400kV 3150A 50KA 2P 2M32 2B16 25mm/kV	PPBBMM	1/3200T MR	1/1600T FR	3200/1 MR
639073	CT 400kV 3150A 50KA 3P 1M32 2B16 25mm/kV	PPPBBM	1/3200T MR	1/1600T FR	3200/1 MR
639074	CT 400kV 3150A 50KA 2P 2M32 2B12 25mm/kV	PPBBMM	1/3200T MR	1/1200T FR	3200/1 MR
639075	CT 400kV 3150A 50KA 3P 1M32 2B12 25mm/kV	PPPBBM	1/3200T MR	1/1200T FR	3200/1 MR
639076	CT 400kV 3150A 50KA 2P 2M32 2B24-16 25mm/kV	PPBBMM	1/3200T MR	1/2400T MR	3200/1 MR
639077	CT 400kV 3150A 50KA 3P 1M32 2B24-16	PPPBBM	1/3200T MR	1/2400T MR	3200/1 MR

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
	25mm/kV				
639078	CT 400kV 3150A 50KA 2P 2M32 2B16-12 25mm/kV	PPBBMM	1/3200T MR	1/1600T MR	3200/1 MR
639079	CT 400kV 3150A 50KA 3P 1M32 2B16-12 25mm/kV	PPPBBM	1/3200T MR	1/1600T MR	3200/1 MR
639112	CT 400kV 4000A 63KA 2P 2M32 2B24 31mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
186755	CT 400kV 3150A 50kA 2P 2M32 2B24 31mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
186754	CT 400kV 3150A 50KA 3P 1M32 2B24 31mm/kV	PPPBBM	1/3200T MR	1/2400T FR	3200/1 MR
186662	CT 400kV 3150A 50KA 2P 2M32 2B16 31mm/kV	PPBBMM	1/3200T MR	1/1600T FR	3200/1 MR
186663	CT 400kV 3150A 50KA 3P 1M32 2B16 31mm/kV	PPPBBM	1/3200T MR	1/1600T FR	3200/1 MR
639090	CT 400kV 3150A 50KA 2P 2M32 2B12 31mm/kV	PPBBMM	1/3200T MR	1/1200T FR	3200/1 MR
639091	CT 400kV 3150A 50KA 3P 1M32 2B12 31mm/kV	PPPBBM	1/3200T MR	1/1200T FR	3200/1 MR
639092	CT 400kV 3150A 50KA 2P 2M32 2B24-16 31mm/kV	PPBBMM	1/3200T MR	1/2400T MR	3200/1 MR
639093	CT 400kV 3150A 50KA 3P 1M32 2B24-16 31mm/kV	PPPBBM	1/3200T MR	1/2400T MR	3200/1 MR
639094	CT 400kV 3150A 50KA 2P 2M32 2B16-12 31mm/kV	PPBBMM	1/3200T MR	1/1600T MR	3200/1 MR

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
639095	CT 400kV 3150A 50KA 3P 1M32 2B16-12 31mm/kV	PPPBBM	1/3200T MR	1/1600T MR	3200/1 MR
639080	CT 400kV 2500A 50KA 2P 2M24 2B24 25mm/kV	PPBBMM	1/2400T MR	1/2400T FR	2400/1 MR
639081	CT 400kV 2500A 50KA 3P 1M24 2B24 25mm/kV	PPPBBM	1/2400T MR	1/2400T FR	2400/1 MR
639082	CT 400kV 2500A 50KA 2P 2M24 2B16 25mm/kV	PPBBMM	1/2400T MR	1/1600T FR	2400/1 MR
639083	CT 400kV 2500A 50KA 3P 1M24 2B16 25mm/kV	PPPBBM	1/2400T MR	1/1600T FR	2400/1 MR
639084	CT 400kV 2500A 50KA 2P 2M24 2B12 25mm/kV	PPBBMM	1/2400T MR	1/1200T FR	2400/1 MR
639085	CT 400kV 2500A 50KA 3P 1M24 2B12 25mm/kV	PPPBBM	1/2400T MR	1/1200T FR	2400/1 MR
639086	CT 400kV 2500A 50KA 2P 2M24 2B24-16 25mm/kV	PPBBMM	1/2400T MR	1/2400T MR	2400/1 MR
639087	CT 400kV 2500A 50KA 3P 1M24 2B24-16 25mm/kV	PPPBBM	1/2400T MR	1/2400T MR	2400/1 MR
639088	CT 400kV 2500A 50KA 2P 2M24 2B16-12 25mm/kV	PPBBMM	1/2400T MR	1/1600T MR	2400/1 MR
639089	CT 400kV 2500A 50KA 3P 1M24 2B16-12 25mm/kV	PPPBBM	1/2400T MR	1/1600T MR	2400/1 MR
639096	CT 400kV 2500A 50KA 2P 2M24 2B24 31mm/kV	PPBBMM	1/2400T MR	1/2400T FR	2400/1 MR
639097	CT 400kV 2500A 50KA 3P 1M24 2B24 31mm/kV	PPPBBM	1/2400T MR	1/2400T FR	2400/1 MR

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
676124	CT 400kV 2500A 50KA 3P 1M24 2B20 31mm/kV	PPPBBM	1/2400T MR	1/2000T FR	2400/1 MR
186664	CT 400kV 2500A 50KA 2P 2M24 2B16 31mm/kV	PPBBMM	1/2400T MR	1/1600T FR	2400/1 MR
186665	CT 400kV 2500A 50KA 3P 1M24 2B16 31mm/kV	PPPBBM	1/2400T MR	1/1600T FR	2400/1 MR
186666	CT 400kV 2500A 50KA 2P 2M24 2B12 31mm/kV	PPBBMM	1/2400T MR	1/1200T FR	2400/1 MR
186668	CT 400kV 2500A 50KA 3P 1M24 2B12 31mm/kV	PPPBBM	1/2400T MR	1/1200T FR	2400/1 MR
639098	CT 400kV 2500A 50KA 2P 2M24 2B24-16 31mm/kV	PPBBMM	1/2400T MR	1/2400T MR	2400/1 MR
639099	CT 400kV 2500A 50KA 3P 1M24 2B24-16 31mm/kV	PPPBBM	1/2400T MR	1/2400T MR	2400/1 MR
639100	CT 400kV 2500A 50KA 2P 2M24 2B16-12 31mm/kV	PPBBMM	1/2400T MR	1/1600T MR	2400/1 MR
639101	CT 400kV 2500A 50KA 3P 1M24 2B16-12 31mm/kV	PPPBBM	1/2400T MR	1/1600T MR	2400/1 MR
8388	CT 400kV 3150A 50KA 2PTPY 2M32 2B24 31mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
639106	CT 400kV 3150A 63KA 2P 2M32 2B24 31mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
639107	CT 400kV 3150A 63KA 3P 1M32 2B24 31mm/kV	PPPBBM	1/3200T MR	1/2400T FR	3200/1 MR
639104	CT 400kV 3150A 63KA 2P 2M32 2B16 31mm/kV	PPBBMM	1/3200T MR	1/1600T FR	3200/1 MR

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
639105	CT 400kV 3150A 63KA 3P 1M32 2B16 31mm/kV	PPPBBM	1/3200T MR	1/1600T FR	3200/1 MR
639110	CT 400kV 3150A 63KA 2P 2M32 2B24 25mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
639111	CT 400kV 3150A 63KA 3P 1M32 2B24 25mm/kV	PPPBBM	1/3200T MR	1/2400T FR	3200/1 MR
639108	CT 400kV 3150A 63KA 2P 2M32 2B16 25mm/kV	PPBBMM	1/3200T MR	1/1600T FR	3200/1 MR
639109	CT 400kV 3150A 63KA 3P 1M32 2B16 25mm/kV	PPPBBM	1/3200T MR	1/1600T FR	3200/1 MR
639102	CT 400kV 4000A 63kA 4P 2M 25mm/kV	PPPPMM	1/3200T MR	—	3200/1 MR
639103	CT 400kV 4000A 63kA 4P 2M 31mm/kV	PPPPMM	1/3200T MR	—	3200/1 MR
400kV Composite Current Transformers					
639740	CT 400kV 4000A 50kA 4P2M 38mm/kV	PPPPMM	1/3200T MR	—	3200/1 MR
639744	CT 400kV 3150A 50kA 4P2M 38mm/kV	PPPPMM	1/3200T MR	—	3200/1 MR
639709	CT 400kV 3150A 50kA 2P2M2B24 31mm/kV	PPBBMM	1/3200T MR	1/2400T FR	3200/1 MR
639730	CT 400kV 3150A 50kA 3P1M2B24 31mm/kV	PPPBBM	1/3200T MR	1/2400T FR	3200/1 MR
639725	CT 400kV 3150A 50kA 2P2M2B24-16 31mm/kV	PPBBMM	1/3200T MR	1/2400T MR	3200/1 MR
639732	CT 400kV 3150A 50kA 3P1M2B24-16 31mm/kV	PPPBBM	1/3200T MR	1/2400T MR	3200/1 MR
639729	CT 400kV 3150A 50kA 2P2M2B16-12 31mm/kV	PPBBMM	1/3200T MR	1/1600 MR	3200/1 MR
639733	CT 400kV 3150A 50kA 3P1M2B16-12	PPPBBM	1/3200T MR	1/1600 MR	3200/1 MR

SAP Number	Short Technical Description	Core Layout	Protection Core (P)	Buszone Core (B)	Measurements Core (M)
	31mm/kV				
765kV Composite Current Transformers					
639168	CT 765KV 800A 50KA 2P1M 25MM/KV	PPM	1/800T FR	—	800/1 FR
400484	CT 765KV 800A 50KA 2P1M 31MM/KV	PPM	1/800T FR	—	800/1 FR
639170	CT 765KV 3150A 50KA 4P2M 25MM	PPPPMM	1/3200T MR	—	3200/1 MR
403346	CT 765KV 3150A 50KA 4P2M 31	PPPPMM	1/3200T MR	—	3200/1 MR
1kV Toroidal Current Transformer					
639174	CT 1kV 800A 2P (TPY) Dry type toroidal	PP	1/800T FR	—	—

Notes:

1) There are current transformers used in Eskom which are regarded as non-standard due to low utilisation, when they are require, their special requirements shall be stated in technical schedule A.

2) Current transformers with 3 * Protection cores, 1 * Metering core and 2 * Bus zone cores are used for capacitor banks application. The core layout thereof shall be PPPBBM.