Eskom	Standard	Technology

Title: **HIGH VOLTAGE SINGLE PHASE OUTDOOR POWER VOLTAGE TRANSFORMERS STANDARD**

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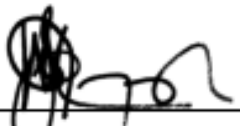		
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SCOT Study Committee Number/Name: **Plant Equipment**

Content

Tables

1. Introduction

Power voltage transformers are used to provide low voltage power supply for auxiliary loads in places where low voltage power supply is not available. They offer a cheaper alternative where medium voltage transformation is not readily available. These units combine the attributes of an inductive voltage transformer with a distribution type transformer. They can supply several kVA low voltage power directly from a high voltage source.

2. Supporting clauses

2.1 Scope

This document specifies Eskom's requirements for the manufacture, testing at works and where required, delivery to site and erection of power voltage transformers ranging from 44kV – 400kV. It must be read in conjunction with IEC 61869-3 and IEC 60076-1. The testing requirements discussed in this document are as per the previously mentioned IEC documents. Any differences that have a technical or financial impact must be agreed on by Eskom.

2.1.1 Purpose

The document is compiled to standardise Eskom's requirements for power voltage transformers.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

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 60076–1: Power transformers Part 1: General

[4] IEC 60376: Specification of technical grade sulfur hexafluoride (SF_6) for use in electrical equipment

[5] IEC 61869–1: Instrument transformers Part 1: General requirements

[6] IEC 61869–3: Instrument transformers Part 3: Additional requirements for inductive voltage transformers

[7] 240 – 75655504: Corrosion protection standard for new indoor and outdoor Eskom equipment, components, materials and structures manufactured from steel standard

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

[9] IEC 60068 – 2 – 17: Basic environmental testing procedures - Tests - Test Q: Sealing

[10] IEC 60529: Degrees of protection provided by enclosures (IP Code)

[11] IEC 60269 – 2: Low voltage fuses – Supplementary requirements for fuses for use by authorized persons

[12] IEC 60947-7-1: Low-voltage switchgear and controlgear - Ancillary equipment - Terminal blocks for copper conductors

[13] IEC 60815 – 2: Selection and dimensioning of high voltage insulators intended for use in polluted conditions – Ceramic and glass insulators for a.c. systems

[14] IEC 61462: Composite hollow insulators - Pressurized and unpressurized insulators for use in electrical equipment with rated voltage greater than 1000V

2.2.2 Informative

[15] IEC 60038: IEC standard voltages

[16] IEC 62271-1: High-voltage switchgear and control gear Part 1: Common specifications

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.
Burden	The admittance of the secondary circuit expressed in siemens and power factor (lagging or leading) NB: The burden is usually expressed as the apparent power in volt-amperes, absorbed at a specified power factor and at the rated secondary voltage.
Creepage Distance	Shortest distance, in millimetres, along the surface of the insulating material between two conductive parts
Distribution Transformer	A transformer that provides the final voltage transformation in the electric power distribution system, stepping down the voltage used in the distribution lines to the level used by the customer.
Effectively earthed neutral system	System whose neutral point is earthed directly without inserting any resistor or impedance device.
Inductive Voltage Transformer (Voltage Transformer)	An instrument transformer in which the secondary voltage, in normal conditions of use, is substantially proportional to the primary voltage and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections
Non-effectively earthed neutral system	System whose neutral point is earthed through a resistor or impedance device.
Power Voltage Transformer	An instrument transformer in which the secondary voltage, in normal conditions of use, is substantially proportional to the primary voltage and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections. This instrument transformer can also supply limited kVA low voltage directly from high voltage.
Primary Winding	The winding to which the voltage to be transformed is applied
Rated Burden	The value of the burden on which the accuracy requirements of this standard are based
Rated Primary Voltage	The value of the primary voltage which appears in the designation of the transformer and on which its performance is based
Rated Secondary Voltage	The value of the secondary voltage which appears in the designation of the transformer and on which its performance is based.
Secondary Winding	Winding which supplies the voltage circuits with auxiliary power.

2.3.2 Disclosure classification

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

2.4 Abbreviations

Abbreviation	Description
IVT / VT	Inductive Voltage Transformer
kV	kilo-Volts
kVA	kilo-Volt-Ampere
kW	Kilo-Watt
MCCB	Moulded-Case circuit Breaker
ºC	Degree Celsius
Pa	Pascal
PVT	Power Voltage Transformer
SANS	South African National Standards

2.5 Roles and responsibilities

All Eskom employees and/or appointed bodies involved in the procurement of power voltage transformers of nominal voltages from 44kV up to 400kV 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 instrument 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. Requirements

3.1 Life expectancy

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

3.2 General requirements

3.2.1 Service conditions

Unless otherwise specified in technical schedule A (see annexure B), the following standard service conditions apply:

a) Equipment will be operated outdoors;

b) Altitude: up to 1800m;

c) Ambient air temperatures:

1) Minimum: -5°C

2) Maximum: 40°C

3) Daily Average: 35°C

4) Yearly average: 25°C

d) Average relative humidity: not exceeding 95% (measured for a period of 24 hours)

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

f) Lightning – extremely severe

g) Seismic requirements – 0,3g (IEEE 693 – moderate level)

The life expectancy of PVTs shall be 25 years under normal service conditions

3.2.2 Earthing

For operating voltages of 132 kV or higher, the system shall be considered as effectively earthed, and non-effectively earthed for lower voltages. The system earthing shall be specified in schedule A.

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);

d) Rated secondary voltage;

e) Rated output;

f) Rated accuracy class

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

4.2 Highest Voltage for Equipment

The system voltages required are specified in table 1.

Table 1: Rated primary insulation levels for PVTs

Nominal system voltage U_n (kV rms)	Highest system voltage U_m (kV rms)	Rated lightning impulse withstand voltage (kV peak)	Rated power frequency withstand voltage (kV rms)	Rated switching withstand voltage (kV peak)
0.4	0.42	-	3	-
44	52	250	95	
66	72.5	350	140	-
88	100	550	230	-

Nominal system voltage U_n (kV rms)	Highest system voltage U_m (kV rms)	Rated lightning impulse withstand voltage (kV peak)	Rated power frequency withstand voltage (kV rms)	Rated switching withstand voltage (kV peak)
132	145	650	275	-
220	245	1050	460	-
275	300	1050	460	850
400	420	1425	630	1050

The standard values of rated primary voltage of a PVT connected between one line of a three-phase system and earth shall be $1/\sqrt{3}$ times the nominal system voltage.

4.3 Rated Insulation levels

These requirements apply to all power voltage transformers.

4.3.1 Rated insulation levels for primary windings

The rated insulation level of a primary winding of a PVT shall be based on its highest voltage for equipment U_m.

a) For windings having Um < 300kV, the rated insulation level is determined by the rated lightning impulse and power-frequency withstand voltages and shall be chosen in accordance with table 1.

b) For windings having Um ≥ 300kV, the rated insulation level is determined by the rated switching and lightning impulse withstand voltages and shall be chosen in accordance with table 1.

4.3.2 Other requirements for primary winding insulation

a) Windings having the highest voltage for equipment Um ≥ 300 kV shall withstand the power-frequency withstand voltage specified in table 1.

b) The terminal of the primary winding intended to be earthed shall, when insulated from the case or frame, be capable of withstanding the rated power-frequency short-duration withstand voltage of 3kV (r.m.s.).

c) The partial discharge level shall not exceed the limits specified in table 2, at the partial discharge test voltage specified in the same table, after pre-stressing performed according to procedures of IEC61869-1.

Table 2: Partial discharge test voltages and permissible levels

PD Test Voltage (rms)	Maximum Permissible PD level
U_m	10
1.2* $U_m/\sqrt{3}$	5

d) A PVT must be able to withstand a chopped lightning impulse voltage applied to its primary terminals having a peak value of 115% of the rated lightning impulse withstand voltage.

e) Capacitance and dielectric dissipation factor requirements apply to PVTs having Um ≥ 72.5kV, with liquid immersed primary insulation or gas insulated PVTs with capacitance grading insulation system. The values of capacitance and dielectric dissipation factor (tan δ) shall be referred at the rated frequency and at a voltage level in the range from 10kV to $Um/\sqrt{3}$.

4.3.3 Between-section insulation requirements

For secondary windings divided into two or more sections, the rated power-frequency withstand voltage of the insulation between sections shall be 3kV.

4.3.4 Insulation requirements for secondary terminals

The rated power-frequency withstand voltage for secondary windings insulation shall be 3kV.

4.3.5 Rated Frequency

The rated frequency is 50Hz.

4.3.6 Rated Voltage factor

The voltage factor is determined by the maximum operating voltage which, in turn is dependent on the system and the power voltage transformer primary winding earthing conditions. The standard voltage factors appropriate to different earthing conditions are mentioned below:

a) The PVT shall be capable of operating continuously with a rated voltage factor of 1,2

b) The PVT shall be capable of operating for 30 seconds with a rated voltage factor of 1,5 for effectively earthed systems.

c) The PVT shall be capable of operating for 30 seconds with a rated voltage factor of 1,9 for non-effectively earthed systems.

4.4 Rated Secondary Voltage

The number of windings required and their purpose shall be stated in technical schedule A (see annexure B) and their rated secondary outputs are given in table 3.

Table 3: Rated Secondary Voltages for PVTs

Winding type	Output voltage (V)
Power	230 ($400/\sqrt{3}$)

4.5 Rated Power Winding Output

The required output of a PVT can range from 10kVA to 125kVA and this shall be specified in schedule A (see annexure B)

4.6 Short Circuit Protection

a) Protection against short circuits shall be provided by MCCBs in the secondary winding circuits and must be located in the terminal box.

b) The supplier shall state, in schedule B, the calculated primary and secondary short circuit currents for a short circuit on the secondary terminals, assuming zero source impedance.

c) The Moulded-case circuit breakers shall:

1) Comply with SANS 156

2) Have all MCCB terminal suitable shrouded to prevent inadvertent human contact

3) Have a load capability inherently independent of ambient temperature or shall be fully ambient temperature compensated up to 80^{o}C.

4) Be equipped with trip alarm contacts which are unaffected by the manual operating of the circuit breaker

5) Have adequate fault interrupting capacity, assuming the transformer impedance to be the only limiting factor.

5. Design Requirements

5.1 Oil Insulated PVTs

a) The oil shall comply with IEC60296.

b) The details of the manufacturer and manufacturer type designation of oil shall be stated in schedule B.

c) The quantity of oil shall be stated in schedule B.

d) PVTs shall be hermetically sealed and the filling and oil draining facilities shall be provided. These shall be suitably sealed below the normal operating oil level and shall not leak oil when the PVT is tested.

e) The method used to allow for the expansion of oil shall be submitted for approval. If bellows are used, they shall be of stainless steel.

f) PVTs shall be supplied with an oil level indicator that can be read from ground level with the PVT mounted on its structure as in service. Details of the oil level indicator shall be submitted for approval. The oil level indicator shall be flush mounted and securely attached throughout its entire perimeter to the tank, conservator or expansion chamber. The sight glass material shall be resistant to ultraviolet radiation and shall be protected from accidental damage. The oil in the chamber shall not be exposed to the outside atmosphere.

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

h) PVTs shall be supplied with gasket joints below oil level.

5.2 Gas Insulated PVTs

a) Gas insulated PVTs shall be clearly labelled to indicate the type of gas and the operating pressure of the insulating gas.

b) Facilities shall be provided at the bottom of the PVT to allow for filling, evacuating and topping up of gas.

c) Sulphur hexafluoride (SF_6) gas shall comply with requirements of IEC 60376. Details of any alternative gases or gas mixtures offered, including applicable specifications, shall be stated in schedule B.

d) Permanent gas-density monitoring devices shall be provided at the base of the PVTs. The readable gas density monitoring devices shall be self-powered. The device shall contain first stage and second stage alarm signalling contacts wired to the secondary terminal strips.

e) There shall be visible indication of the gas density in the PVT.

f) It shall be possible to replace the gas-density monitoring device without losing gas pressure.

g) The method of sealing of the PVTs and any need for gas replenishment shall be stated by the supplier in schedule B. See IEC 60068-2-17 for details of leakage rates and the expected life before replenishments.

5.3 Requirements for temperature rise of parts and components

The temperature rise of windings, magnetic circuits and any other parts of the PVT shall not exceed the appropriate values given in IEC 61869-1. When operating under the specified rated conditions.

5.4 Requirements for earthing

a) An earthing flag of 5mm x 50mm x 100mm with 14mm hole at 50mm centres shall be arranged vertically. The flag shall be situated in close proximity to a tank mounting bolt hole on the same side as the terminal box.

b) Alternative designs shall be submitted for approval.

NB: In the case of painted tanks, the underside of the transformer tank mounting flanges should be zinc metal sprayed, and should not be painted to allow earthing to be achieved through the mounting surfaces.

5.4.1 Creepage distance

The equipment shall comply with the creepage distances as specified in IEC61869-1. The two levels, heavy and very heavy pollution shall apply. The required level shall be specified in schedule A of an enquiry document.

5.4.2 Radio Interference Voltage (RIV)

This requirement applies to PVTs having Um ≥ 123kV.

a) The radio interference voltage shall not exceed 2500µV at 1.1 Um/$\sqrt{3}$ under the test and measuring conditions described in IEC61869-1.

5.4.3 Transmitted overvoltages

These requirements apply to PVTs having Um ≥ 72,5kV. The overvoltages transmitted from the primary to the secondary terminals shall not exceed the values specified in table 5 under the test conditions described in IEC61869-1.

Table 4: Transmitted overvoltage limits

Type of impulse	Impulse requirements
Peak value of the applied voltage(Up)	1,6 x $\frac{\sqrt{2}}{\sqrt{3}}$ x Um
Waveshape characteristics Conventional front time (T1)a Time to half-value (T2)	 0,50µs ± 20% ≥ 50µs
Transmitted overvoltage peak value limits (Us)	1.6kV
NB: Waveshape characteristics are representative of voltage oscillations due to switching operations	

5.5 Short-circuit withstand capability

The power voltage transformer shall be designed and constructed to withstand without damage, when energized at rated voltage, the mechanical and thermal effects of an external short-circuit for the duration of 1 second.

5.6 Mechanical requirements

These requirements apply only to PVTs having Um ≥ 72,5kV. Table 6 gives guidance on the static loads that the PVT shall be capable of withstanding. The figures include loads due to winds and ice. The specified test loads are given in table below.

Table 5: Static withstand test loads

Static withstand test load F_R (N)	
Highest Voltage (Um in kV)	**Voltage terminals**
72,5 – 100	500
123 – 170	1000
245 – 362	1250
≥420	1500

5.7 Multiple Chopped Impulse

The primary terminals of oil-immersed PVTs having U_m ≥ 300kV shall withstand multiple chopped impulses in accordance with 7.4.2 of IEC 61869-1.

5.8 Internal arc fault protection

The requirements apply to PVTs having U_m ≥ 72,5kV and the protection class I performance is required as per IEC 61869-1.

5.9 Core Design

The supplier shall have magnetic field plotting capability and other data to determine the losses and temperatures resulting from the leakage flux. An analysis shall be made to determine the temperatures of the components subject to leakage fields that can produce excessive heating. This will include but not limited to tie plates, outer core lamination, tank walls, etc.

5.9.1 Material

The core shall be manufactured of high permeability; non-ageing cold rolled grain oriented steel sheet laminations having smooth, insulated surfaces. The maximum allowable size of burrs on the slit or cut edge of the electromagnetic steel shall not be capable of causing damage to the insulation between sheets and shall be less than 0.02mm. The core shall be of mitre construction. The core sheets stacking and all the insulation designed in a way that no detrimental changes in physical or electrical properties will occur during the lifetime.

6. Construction Requirements

6.1 Primary terminals

The primary terminals type and orientation shall be specified in schedule B. Terminals shall be of electro-tinned copper or aluminium and the standard dimensions used in Eskom are given in table 7 below.

Table 6: Terminals dimensions

Terminal Type	Diameter (mm)	Length (mm)
Cylindrical HV Terninals	26	100
	38	125
8 hole HV terminal	-	100 x 200

NB: The holes of the 8 terminal have a diameter of 14mm at 50mm centres as per IEC 62271-301.

6.2 Secondary terminals

6.2.1 Power Terminals

a) The PVT LV terminals, where applicable, shall be extended to a moulded-case air circuit-breaker.

b) Bushings, lugs, terminations, conductors, circuit breakers shall be capable of handling continuous full load current as well as 130% overcurrent for 1 hour and 120% overcurrent for 2 hours.

6.2.2 Voltage Transformer Terminals

a) The bushings used for bringing the secondary connections through the tank into the secondary terminal box shall not be used as secondary terminals for service conditions, unless approved.

b) Studs shall have distances of not less than 25mm. A minimum clearance of 12mm shall be maintained between terminals.

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

6.2.3 Terminal Box

a) LV equipment shall be mounted in a dust, vermin, weather-proof, lockable (top and bottom) enclosure (using a standard Eskom padlock) with a vertically hinged axis door with IP 56 rating. The door of the enclosure must allow access to the entire opening of the enclosure (same size as enclosure).

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

c) The primary cable enclosure and cables shall conform to the voltage and corresponding required insulation levels specified in the schedule A in line with the requirements of Table 3.

d) The LV power cable and secondary control cables shall enter the enclosure from the bottom. The terminal box shall have an opening at the bottom to allow for the cables. The opening shall be covered externally by undrilled removable gland plates of brass (of minimum thickness 2mm), aluminium alloy (of minimum thickness 3mm) or stainless steel (of minimum thickness 2mm). Unless otherwise specified the gland plate and the opening shall have a minimum effective area of 75mm x 50mm.

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

f) The beginning and end of each winding shall be wired to suitable terminals accommodated in the terminal box.

g) An earth stud shall be provided for earthing of the primary winding neutral and secondary windings inside the terminal box. The earth stud shall have a minimum diameter of 6mm and have an external connection to the main earthing system. The earth stud must be welded to the terminal box.

6.3 Tank earthing terminals

An earthing flag of 5mm x 50mm x 100mm (minimum), with two 14mm holes at 50mm centres, shall be arranged vertically. The flag shall be situated in close proximity to a tank mounting hole on the same side as the terminal box. Alternative designs shall be submitted for approval.

NB: In the case of painted tanks, the underside of the transformer tank mounting flanges should be zinc metal sprayed, and should not be painted to allow earthing to be achieved through the mounting surfaces.

Insulators

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

b) The name of the manufacturer of the HV insulators shall be stated in schedule B and detailed drawings of insulators shall be supplied with the tender.

6.4 Mounting arrangement of PVTs

a) The base mounting arrangement for PVTs 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 706mm.

b) In case of mounting holes with spacing greater that a square of 706mm, the supplier shall state the dimensions in schedule B.

6.5 Corrosion protection

a) Corrugated tanks are not acceptable. Tanks and fittings shall be such that water cannot collect at any point on the outside surfaces.

b) Unless otherwise approved, all ferrous parts associated with PVTs shall either be:

1) Hot dip galvanised in accordance with SANS 121, with the coating thickness not less than 90µm or

2) Zinc metal sprayed in accordance with SANS 2063, with the coating thickness not less than 80µm

6.6 Rating plates and diagram plates

Rating plates and diagram plates shall be engraved or have the information into an intrinsically corrosion-resistant material, and shall be externally mounted. Rating plates and diagram plates shall be fixed on the main body of the PVT and not to any removable part. The rating plates and diagram plates shall be so positioned that they may easily be read by personnel without their lives being endangered.

The rating plates shall display the following information:

a) Applicable version of standard

b) The purchase order number, date of manufacture

c) The rated voltage factor and the corresponding time of rating

d) The rating of the fuses as applicable

e) The volume of oil in litres for oil filled PVTs

f) The gas type and pressure for gas filled PVTs

g) The terminal markings and the relative physical arrangement of the PVT secondary windings with respect to the primary terminal

6.7 Warranty

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

7. Documentation

7.1 General

Unless otherwise specified in schedule A, a digital (electronic) copy of all documentation pertaining to the equipment offered shall be provided. The digital copy shall be compatible with “Adobe Acrobat PDF” format.

7.2 Tender documentation

The following drawings and technical information shall be submitted with the tender:

a) The completed technical schedule

b) Technical deviation sheet

c) Outline drawing of the PVT

d) Insulator drawing of PVT

e) User manual

7.3 Details of drawings and technical information

7.3.1 Outline drawing

A typical section drawing that shows the following minimum information shall be provided for each PVT type such that the physical arrangement can be correlated with the electrical schematic arrangement:

a) Mounting details

b) Primary terminal dimensions and markings

c) Overall dimensions

d) Position of the earthing terminal

e) The height of the gland plate in the terminal box above the base and the distance of the terminal box centre line from the PVT

f) Total creepage and arcing distance of the hollow core insulator

g) The mass of the complete PVT and the volume of oil or the mass of the insulating gas.

7.3.2 Section Drawing

Sectional arrangement drawing(s) which depicts the following details shall be supplied upon contract placement:

a) Relative position of the core and windings

b) Hollow core insulator

c) Oil sealing or gas sealing arrangements

d) In case of oil-paper insulated PVTs, the method used to accommodate expansion of the oil and

e) Pressure relief devices where applicable

7.3.3 Detailed drawing of the insulator

A section drawing of the hollow core insulator that depicts all pertinent dimensions for the evaluation of compliance with IEC 60815 and IEC 61462 shall be provided.

7.3.4 Detailed drawing of secondary terminal box

A detailed drawing of the secondary terminal box shall be provided. This should reflect the following:

a) Method of affixing the cover

b) Position and dimensions of gland plate(s)

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

d) The breathing arrangement

7.4 Instruction Manual

The instruction manual shall include the details of the recommended transport, handling, storage, installation and maintenance and inspection procedures applicable during the life of the equipment. The procedure for gas filling of gas-insulated PVTs shall be detailed in the manual.

7.5 Descriptive pamphlets and instruction books

a) Descriptive pamphlets and instruction books that cover the equipment offered shall be supplied to the purchaser as soon as possible, but not later than the delivery date of the PVTs. A complete set of test certificates as specified in technical schedule A shall be included with each instruction book.

b) The instruction book shall include the details of the recommended oil sampling procedures, together with the necessary sectional and other sketches of oil sampling devices provided and recommended maintenance and inspections to be done during the life of the equipment.

8. Tests

8.1 Type Tests

Unless valid and approved type test certificates specified in schedule A and in IEC 61869-1 are available, carryout type tests on one fully assembled power voltage transformer of each type and rating at an approved test facility. Type tests shall be followed by routine tests. The list of type tests is as follows:

a) Temperature rise test

b) Short-time current test

c) Lightning impulse test

d) Switching impulse test

e) Wet test for outdoor type transformers

f) Test for accuracy

g) Measurement of RIV

8.2 Routine tests

Each fully assembled PVT shall be subjected to the following routine tests at the manufacturer’s work station:

a) Verification of markings

b) Power frequency withstand test on primary winding

c) Power frequency withstand test on secondary winding

d) Power frequency withstand test between sections

e) Partial discharge measurement

f) Test for accuracy

g) Enclosure tightness test at ambient temperature

h) Pressure test for the enclosure

The sequence of the above tests is not prescribed but the accuracy test shall be performed after other tests have been completed.

8.3 Special tests

Where so specified in schedule A, special tests will be performed and maybe specified as either type tests or special tests. The following tests shall be performed upon agreement between the manufacturer and the purchaser:

a) Chopped impulse test on primary terminals

b) Measurement of capacitance and dielectric dissipation factor

c) Transmitted overvoltage measurement

d) Mechanical test

e) Internal arc fault test

f) Corrosion test

All the above tests can be found in IEC 61869-1 and shall be in accordance with the insulation levels specified in table 1.

8.4 Test certificates

a) All test certificates shall be fully documented in English.

b) In case they are translated to English, a copy of test in the original language must be submitted as well.

c) Each PVT shall be delivered with one copy of all routine test certificates. The certificates shall be packed in a waterproof container and housed inside the terminal box of the PVT.

9. Marking, labelling and packaging

Recorded information on the following is required:

a) Long term storage of spare PVTs

b) Handling or preparation for transport with details of lifting and support positions and

c) Correct handling and slinging methods

10. 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)

11. Revisions

Date	Rev	Compiler	Remarks
Nov 2021	2	S. Maphosa	Removed protection and metering winding requirements.
June 2016	1	S. Maphosa	Compiled to specify Eskom's PVT requirements.

12. Development team

The following people were involved in the development of this document:

- Sibongile Maphosa
- Sipho Zulu

13. Acknowledgements

The development team would like to acknowledge all members of the Instrument Transformers Care Group who contributed to this standard.

Annex A – Guide on preparing an enquiry

Guide on preparing an enquiry

A.1 Schedule A

Schedule A lists the requirements to be specified by Eskom in enquiries and orders. These requirements include references to relevant sub clauses in this standard, to assist in compiling the schedules.

Schedule B

The tenderer shall complete schedule B. By doing this, the tenderer will be stating compliance with this standard and will provide the information the purchaser has requested. Any deviations from Eskom's requirements shall be captured in the deviation schedule (see annex c).

Commercial Conditions

Eskom will indicate the commercial conditions applicable. Requirements for delivery, storage, packing and marking should be attended to in this part of the enquiry.

Quality Assurance

This standard does not cover Eskom's possible requirements in respect of quality assurance, quality control, inspections, etc.

Testing

Attention should be paid to the subject of tests and their related costs. Tests should be carried out by a competent and accredited party. Price schedules should be so drawn up and covering letters so worded that the cost of all services such as tests, delivery and spares are declared and allowed for in the tender.

Revision of standards

This standard, as has been indicated, is based on a set of defined standards which may have been revised or amended. Eskom would in principle wish to employ the latest standards. The recommended approach is to secure an undertaking from a supplier to review the latest versions and amendments and to incorporate these where possible and agreeable to both parties, and should be properly assessed.

Annex B – Schedule B: Particulars of equipment to be supplied by tenderer

Item	240-105478209 Sub-clause	Description	Unit	Schedule A	Schedule B
1		**Manufacturing details**			
		Manufacturer		xxxxxxxx	
		Manufacturer's (equipment) designation		xxxxxxxx	
2	**3.1**	**General requirements**			
	3.1.1	**Service Conditions**			
		Ambient air temperature	°C	-10 to +50	
		Altitude	m	1800	
		Average relative humidity	%	95	
		Wind pressure	Pa	700Pa	
		Level of pollution			
		a) Heavy	mm	Heavy	
		Arcing distance	mm	xxxxxxxx	
		b) Extra Heavy	mm	Extra Heavy	
		Arcing distance	mm	xxxxxxxx	
		Seismic requirements	g	0.3	
3	**4.2**	**Ratings / Application details**			
		Indoor or outdoor use		Outdoor	xxxxxxxx
		Nominal r.m.s. system voltage (U_n)	kV		xxxxxxxx
		Maximum r.m.s. system voltage (U_m)	kV		xxxxxxxx
		Number of phases of the system		3	xxxxxxxx
		Frequency	Hz	50	xxxxxxxx
		Method of earthing (effective or non-effective)			xxxxxxxx
		Single phase or 3 phase PVT		1 Phase	xxxxxxxx
		Short time power frequency withstand level	kV		xxxxxxxx
		Lightning impulse withstand level	kV		xxxxxxxx
		Switching withstand voltage level	kV		xxxxxxxx
4	**6.4**	**Details of insulation materials**			
		Manufacturer of HV porcelain insulators		xxxxxxxx	
		Manufacturer of HV composite insulators		xxxxxxxx	
		Detailed drawing of insulator		Yes	
		Compliance with Specification: IEC 60815		Yes	
		Insulation medium (gas or oil)		xxxxxxxx	

Item	240-105478209 Sub-clause	Description	Unit	Schedule A	Schedule B
5	**5.1**	**Details of paper oil insulated PVTs**			
		Oil Supplier		xxxxxxxx	
		Type of oil		xxxxxxxx	
		Oil supplier type designation		xxxxxxxx	
		Oil to be certified to contain no PCBs (zero count)		Yes	
		Quantity of oil required	L	xxxxxxxx	
		Expansion accommodation method		xxxxxxxx	
		Details of sealing arrangements		xxxxxxxx	
		Oil-level indicators		Yes	
		Oil sample valve required?		Yes	
6	**5.2**	**Details of gas insulated PVT**			
		Type of gas		xxxxxxxx	
		Operating pressure	kPa	xxxxxxxx	
		Provide details of filling/evacuation valves		Yes	
		Provide details of density meter		Yes	
		Provide weight of gas	kg	xxxxxxxx	
		Provide certificate of compliance		Yes	
		Method of sealing		Yes	
7	**6.1**	**Primary Terminals Details**			
		Details of stem type terminal			
		Material (Aluminium or electro-tinned copper)		xxxxxxxx	
		Diameter (26 or 38)	mm	xxxxxxxx	
		Minimum length	125	xxxxxxxx	
		Orientation		Vertical	
		Details of earthing terminal suitable for a 50 x 3mm strap		xxxxxxxx	
		Details of pad type terminal			
		Number of holes	Unit	8	
		Hole centres	mm	50	
		Hole size (diameter)	mm	14	
		Orientation		Vertical	

Item	240-105478209 Sub-clause	Description	Unit	Schedule A	Schedule B
		Design Details			
	4.3.6	**Voltage factor**			
		a) Continuous	Unit	1.2	
		b) 30s	s		xxxxxxxx
		Primary Voltage	kV		xxxxxxxx
	4.4	**PVT secondary windings requirements**			
		a) Power	Unit		xxxxxxxx
	4.4	**PVT secondary voltage**			
		a) Power	V	400/√3 V	xxxxxxxx
	4.5	**Rated Burden per phase**			
		a) Power Winding	kVA		
		HV neutral to be earthed		Yes	xxxxxxxx
	4.6	**Short circuit protection**			
		a) Protection of secondary winding required?		Yes	xxxxxxxx
		b) By means of MCCB		xxxxxxxx	
		c) Current rating	A	xxxxxxxx	
		d) Make and type of protection			
		e) White phase or neutral to be earthed?		Neutral	xxxxxxxx
		Short circuit currents			
		a) Calculated secondary short circuit current	kA	xxxxxxxx	
		b) Maximum permissible duration of secondary short circuit current	S	1	xxxxxxxx
		c) Operating time for secondary short circuit	S	xxxxxxxx	
		d) Calculated primary current for secondary short circuit assuming zero impedance		xxxxxxxx	
		Number of core limbs		xxxxxxxx	
	6.2.3	**Secondary terminal box**			
		Number of MCCB's		xxxxxxxx	
		Manufacturer of MCCB's		xxxxxxxx	
		Type of MCCB's		xxxxxxxx	
		Current rating of MCCB's	A	xxxxxxxx	
		MCCB Characteristic curve			
		If MCB is used change-over auxiliary contact required		Yes	
		HV winding earth end to be brought out, with link to earth terminal		Yes	xxxxxxxx
		Dimensions of terminal box			

Item	240-105478209 Sub-clause	Description	Unit	Schedule A	Schedule B
		a) Length	mm	xxxxxxxx	
		b) Height	mm	xxxxxxxx	
		c) depth	mm	xxxxxxxx	
		Minimum effective gland area of secondary terminal box/gland plate; length x width	mm	75 x 50	
		Secondary terminals for protection or metering (Stud type)		Yes	
	6.5	**Mounting arrangements**			
		Outline drawing		Yes	xxxxxxxx
		Holding down bolts to be arranged to fall within a square of maximum dimensions	mm	706	
	6.6	**Metal finish**			
		Is metal spraying of ferrous parts acceptable?		Yes	
		Finish offered on ferrous parts		xxxxxxxx	
		Finish offered on non-ferrous parts		xxxxxxxx	
	6.7	**Rating plates and diagram plates**			
		Materials used for rating plates		xxxxxxxx	
		Material used for diagram plates		xxxxxxxx	
		Method of fixing diagram plates and rating plates		xxxxxxxx	
	7.3 & 7.4	**Drawings and instruction manuals**			
		Quantity of drawings and literature required with tender	Unit	1	xxxxxxxx
		Information in electronic format (PDF)		Yes	xxxxxxxx
		Mass of complete transformer	kg	xxxxxxxx	
		Number of instruction books and descriptive pamphlets per order	Unit	3	xxxxxxxx
		Drawing numbers			
		a) Outline drawing		xxxxxxxx	
		a) Assembly		xxxxxxxx	
		b) Terminal box		xxxxxxxx	
		c) Terminal marking		xxxxxxxx	
		d) Rating plate		xxxxxxxx	
		e) Diagram plate		xxxxxxxx	
	8	**Tests**			
	8.1	**Type Tests**			
		Are valid type test results available?		xxxxxxxx	

Item	240-105478209 Sub-clause	Description	Unit	Schedule A	Schedule B
		If No, are type tests to be performed?		Yes	xxxxxxxx
		If required, specify test facility		xxxxxxxx	
	8.2	**Routine tests**			
		Test certificates of individual routine tests are required and shall be placed in the terminal box		Yes	xxxxxxxx
	8.3	**Special Tests**			
		Chopped impulse tests		Yes	
		Measurement of capacitance and dissipation factor		Yes	
		Transmitted overvoltage		Yes	
		Mechanical strength		Yes	
		Internal arc		Yes	
		Corrosion		Yes	
		Are valid test certificates for the special tests available?		xxxxxxxx	
		If No, are the special tests to be performed?		Yes	
		If required, specify test facility		xxxxxxxx	