



A Division of Transnet SOC Limited

TECHNOLOGY MANAGEMENT

SPECIFICATION

REQUIREMENTS FOR OUTDOOR POST TYPE CURRENT TRANSFORMERS FOR TRACTION AND DISTRIBUTION SUBSTATIONS.

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1.0 SCOPE

- 1.1 This specification covers Transnet Freight Rail's requirements for the design, manufacture, testing and supply of outdoor post type current transformers for use with electrical measuring instruments and electrical protection devices.
- 1.2 The current transformers shall be suitable rated for nominal system phase to phase rms voltages ranging from 22 kV up to 220 kV.

2.0 STANDARDS

- 2.1 Unless otherwise specified all materials used and equipment developed and supplied shall comply with the current equivalent edition of the relevant SANS, IEC or Transnet Freight Rail publications where applicable.

- 2.2 The following publications/specifications (latest editions) are referred to herein:

2.2.1 SOUTH AFRICAN NATIONAL STANDARD (SANS)

SANS 1019:	Standard voltages, currents and insulation levels for electricity supply.
SANS 60529:	Degree of protection provided by enclosures (IP code)
SANS 61869-1:	Instrument transformers Part 1: General requirements.
SANS 61869-2:	Instrument transformers Part 2: Additional requirements for current transformers.
SANS 62271-204:	High-voltage switchgear and control gear Part 204: Rigid gas-insulated transmission lines for rated voltage above 52 kV
SANS 9001:	Quality management systems - Requirements.

2.2.2 INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60296:	Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear.
IEC 60376:	Specification of technical grade sulfur hexafluoride (SF6) for use in electrical equipment.
IEC 60417:	Graphical symbols for use on equipment.
IEC 60455:	Resin based reactive compounds used for electrical insulation.
IEC 60815:	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions.
IEC 60867:	Insulating liquids - Specifications for unused liquids based on synthetic aromatic hydrocarbons.

2.2.3 TRANSNET FREIGHT RAIL'S SPECIFICATIONS

CEE 0183:	hot dipped galvanizing and painting of electrification steelwork.
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3.0 METHOD OF TENDERING

- 3.1 Tenderers shall indicate clause-by-clause compliance with this specification. This shall take the form of a separate document listing all the specifications clause numbers indicating the individual statement of compliance or non-compliance. This document can be used by tenderers to elaborate on their response to a clause.
- 3.2 A statement of non-compliance shall be motivated by the tenderer.
- 3.3 Tenderers shall submit descriptive literature consisting of a detailed technical specifications,

general constructional details and principal dimensions, together with clear illustrations of the equipment offered.

- 3.4 Failure to comply with clauses 3.1, 3.2 and 3.3 could preclude a tender from consideration.

4.0 SERVICE CONDITIONS

4.1 ENVIRONMENTAL CONDITIONS

Altitude:	0 - 1800 m above sea level
Relative humidity:	10% to 90%
Ambient temperature:	-10° C to +55° C
Wind pressure:	750 Pa
Lightning conditions:	20 ground flashes/km ² per annum
Pollution:	Heavily salt laden with industrial pollutants including diesel-electric locomotive emissions
Electromagnetic interference:	The device shall be used in environments exposing it to substantial electric and magnetic field intensities

4.2 ELECTRICAL SERVICE CONDITIONS

- 4.2.1 The current transformer shall be suitable for single phase AC traction supply systems with nominal voltage ranging from 22 kV – 220 kV AC with +-5% tolerance.
- 4.2.2 The current transformer shall be able to operate at a frequency of 50 Hz with +- 2.5% tolerance.

4.3 MECHANICAL SERVICE CONDITIONS

- 4.3.1 The device may be exposed to vibration and shock. The design must be adequately robust so as to ensure reliability of the equipment under such handling and transportation conditions.

5.0 TECHNICAL REQUIREMENTS

5.1 GENERAL REQUIREMENTS

- 5.1.1 The current transformers shall be designed, manufactured and tested in accordance with the requirements of SANS 61869-1 and SANS 61869-2 specifications.
- 5.1.2 The current transformers shall be suitable for operation under the nominal phase to phase voltages or phase to neutral voltages specified in Appendix A.
- 5.1.3 The current transformers shall be designed for outdoor use.
- 5.1.4 The current transformers shall be provided with measuring and protection cores as specified in Appendix A.
- 5.1.5 For certain applications, dual measuring cores as specified in Appendix A shall be provided for the purpose of ESKOM metering.

5.2 INSULATION LEVELS

The rated insulation levels of the current transformers shall comply with the requirements specified in Table 1.

Table 1 lists the nominal system voltages present on Transnet Freight Rail and the required insulation levels as specified in accordance with SANS 1019.

Highest phase-to-phase r.m.s voltage for equipment. (U_m)	Nominal system phase-to-phase r.m.s. voltage	Rated lightning impulse withstand voltage peak.	Rated short duration power- frequency withstand r.m.s voltage.
24 kV	22 kV	150kV	50 kV
36 kV	33 kV	200 kV	70 kV
52 kV	44 kV	250 kV	95 kV
72,5 kV	66 kV	350 kV	140 kV
100 kV	88kV	380 kV 450 kV	150 kV 185 kV
145 kV	132 kV	550 kV 650kV	230 kV 275 kV
245 kV	220 kV	550 kV 650kV	360 kV 395 kV
Insulation levels for highest voltage for equipment $U_m < 100$ kV are based on an earth fault factor equal to $\sqrt{3}$ and for $U_m > 100$ kV an earth fault factor equal to $0,8\sqrt{3}$.			

TABLE 1: Standard Voltages and insulation levels in accordance with SANS 1019:2014

For the 25 kV and 50kV single phase ac traction systems the ac high voltage circuit breakers shall be designed to the following nominal system phase to phase r.m.s voltages and withstand insulation levels:

- For the 25 kV (phase to earth) ac traction systems the ac high voltage circuit breakers current transformer shall be rated for a nominal system phase to phase r.m.s voltage of at least 44 kV and designed to withstand the required insulation level for that nominal system voltage.
- For the 50 kV (phase to earth) ac traction systems the ac high voltage circuit breakers shall be rated for a nominal system phase to phase r.m.s voltage of at least 88 kV and designed to withstand the required insulation level for that nominal system voltage.

5.2.1 Primary terminal

- 5.2.1.1 The primary terminal insulation levels of the current transformer shall be as per clause 5.2 table 2 of SANS 61869-1 specification.
- 5.2.1.2 The partial discharge level shall not exceed the limits specified in Table 3 of SANS 61869-1 specification. These limits shall be tested as per clause 7.3.2.2 of SANS 61869-1 specification.
- 5.2.1.3 Current transformers that are not Gas Insulated shall be capable 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.

5.2.1.4 The primary terminals shall be of approved type material i.e. aluminium or electroplated copper and shall be able to carry the rated short circuit current of the current transformer.

5.2.1 **Secondary terminal**

5.2.1.1 The rated power-frequency withstand voltage for secondary insulation shall be at least 3 kV.

5.2.1.2 The secondary terminals shall be mounted in a metal terminal box suitable for the termination of the current transformer secondary windings to the outgoing external circuits for the protection relays, metering and indicating instruments.

5.2.1.3 The secondary winding connections shall be brought out through the tank into the terminal box by means of bushings.

5.2.1.4 Links shall be provided for shorting out the secondary windings not in use.

5.2.1.5 A rail mounted terminal strip shall be provided inside the terminal box for the termination of the current transformer secondary connections to the external circuits. The terminals shall be of the screw clamp type or spring-loaded insertion type.

5.2.1.6 The secondary winding terminal box shall be provided with a weatherproof cover and bottom entry cable entries. The degree of protection shall be at least IP 54 in accordance with SANS 60529.

5.2.1.7 An earthing stud of at least 6mm shall be provided inside the terminal box for the earthing of the secondary windings.

5.3 **CURRENT TRANSFORMER RATINGS**

5.3.1 **MEASURING CURRENT TRANSFORMERS**

5.3.1.1 The transformer ratio(s) shall comply with the requirements of Appendix A.

5.3.1.2 The secondary current rating shall be 1 Ampere unless otherwise specified in Appendix A.

5.3.1.3 The minimum rated output burden shall be 10 VA unless otherwise specified in Appendix A.

5.3.1.4 The accuracy class shall be as follows:

- For metering purposes the class of accuracy shall be 0.5 for current transformers with ratios up to 400/1 and class 0.2 for ratios greater than 400/1.
- For Indication or measuring purposes the accuracy class shall be 0.5.

5.3.2 **PROTECTION CURRENT TRANSFORMERS**

5.3.2.1 The transformer ratio(s) shall comply with the requirements of Appendix A.

5.3.2.2 The secondary current rating shall be 1 or 5 Ampere. Refer to Appendix A.

5.3.2.3 The rated output burden shall comply with the requirements of Appendix A but shall not be less than 10 VA.

5.3.2.4 The accuracy limit factor shall be as specified in Appendix A.

5.3.2.5 The accuracy class shall be as specified in Appendix A.

5.3.2.6 The protection core shall be provided with a 10 ampere test winding.

CLASS PX CURRENT TRANSFORMERS

5.3.2.7 Class PX protection current transformers shall be provided where specified in Appendix A.

5.4 **DESIGN AND CONSTRUCTION**

5.4.1 **Requirements for liquid filled in equipment**

5.4.1.1 The manufacturer shall specify the type and the required quantity and quality of the liquid to be used in current transformer.

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

- 5.4.1.3 For synthetic liquid-filled equipment refer to IEC 60867 specification.
- 5.4.1.4 The current transformer shall have a device for checking the liquid level. The device shall indicate whether the liquid level is within the operating range, during operation. This device shall be readable from the ground level.
- 5.4.1.5 The device shall be sealed to avoid any liquid loss. Liquid loss represents a danger of insulation contamination.

5.4.2 Requirements for gas filled in equipment

- 5.4.2.1 The manufacturer shall specify the type and the required quantity and quality in the equipment.
- 5.4.2.2 New SF₆ (sulphur hexafluoride) gas shall comply with IEC 60376 specification.
- 5.4.2.3 The handling of SF₆ gas shall be in accordance with clause 6.2 of SANS 61869-1 specification.
- 5.4.2.4 The maximum allowed moisture content within current transformers filled with gas at rated filling density for insulation shall be as per clause 6.2.2 of SANS 61869-1 specification.
- 5.4.2.5 Gas-insulated transformers having a minimum functional pressure above 0,2 MPa shall be provided with pressure or density monitoring device. Gas monitoring devices may be provided alone or together with the associated equipment.
- 5.4.2.6 All current transformers that use gas, other than air at atmospheric pressure, as an insulating medium shall conform to clause 6.2.4.2 of SANS 61869-1 specification.
- 5.4.2.7 The pressure relief valve shall be protected against any accidental damage.
- 5.4.2.8 For Gas Insulated Switchgear (GIS) current transformers refer to SANS 62271-204, Clause 5.105.

5.4.3 Requirements for solid materials used in equipment

- 5.4.3.1 Specifications for organic material used on current transformer (i.e. epoxy resin, polyurethane resin, epoxy-cycloaliphatic resin, composite material, etc.) shall conform to IEC 60455 series specifications.
- 5.4.3.2 For insulation guidance, IEC 61109 specification for outdoor insulation shall be used.

5.4.4 Requirements for temperature rise of parts and components

- 5.4.4.1 The temperature-rise of windings, magnetic circuits and any other parts of the current transformer shall not exceed the appropriate value given in SANS 61869-1 specification Table 5, when operating under the conditions specified on 4.0 of this specification.
- 5.4.4.2 The influence of altitude on temperature rise of the transformer shall be as per clause 6.4.2 of SANS 61869-1 specification.

5.4.5 Requirements for earthing of equipment

- 5.4.5.1 The frame of each equipment device, if intended to be earthed, shall be provided with a reliable earthing terminal for connection to an earthing conductor suitable for specified fault conditions. The connecting point shall be marked with the "earth" symbol, as indicated by symbol No 5019 of IEC 60417 specification.
- 5.4.5.2 The enclosure of current transformers for gas-insulated switchgear (GIS) shall be connected to earth. All metal parts which do not belong to a main or an auxiliary circuit shall be earthed.
- 5.4.5.3 The continuity of the earthing circuits shall be ensured.
- 5.4.5.4 For the interconnection of enclosures, frames, etc., fastening (e.g. bolting or welding) is acceptable for providing electrical continuity.
- 5.4.5.5 The tank or base of each current transformer shall be fitted with an earthing terminal suitable to accommodate a cable lug for a 95mm² copper conductor or copper busbar for the earthing of the current transformer.

5.4.6 Requirements for the external insulation

- 5.4.6.1 For outdoor instrument transformers with ceramic insulators susceptible to contamination, the creepage distances for given pollution levels shall conform to Table 6 of SANS 61869-1 specification.

5.4.6.2 The creepage distances shall also conform to IEC 60815 specification.

5.4.6.3 For installations at an altitude higher than 1000 m, the arcing distance under the standardised reference atmospheric conditions shall be determined by multiplying the withstand voltages required at the service location by a factor k in accordance with Figure 2 of SANS 61869-1 specification.

5.4.7 Mechanical requirements

These requirements apply only to current transformers having a highest voltage for equipment of 72,5 kV and above.

5.4.7.1 The current transformer shall be capable of withstanding static loads as per table 7 of SANS 61869-1 specification.

5.4.7.2 Provision shall be made that the current transformers can be bolted to the support structure.

5.4.8 Multiple chopped impulse on primary terminals

5.4.8.1 Chopped impulses shall be as per clause 7.4 of SANS 61869-1 specification.

5.4.9 Internal arc fault protection requirements

5.4.9.1 Internal arc fault test on all oil-immersed and gas-insulated free-standing current transformers having rated voltage $\geq 72,5$ kV shall be conducted and classed as per clause 6.9 of SANS 61869-1 specification.

5.4.10 Degrees of protection by enclosures

5.4.10.1 The degree of protection of all current transformers with the associated components shall be as per clause 6.10 of SANS 61869-1 specification; this shall be done in conjunction with SANS 60529 specification.

5.4.11 Electromagnetic Compatibility (EMC)

5.4.11.1 For current transformers that have rated voltage (U_m) ≥ 123 kV, the Radio Interference Voltage (RIV) shall not exceed $2\,500\,\mu\text{V}$ at $1,1\,U_m$.

5.4.11.2 The current transformers that are containing active electronic components shall conform with the requirements of electromagnetic immunity as per clause 6.11 of SANS 61869-1 specification.

5.4.11.3 All current transformers that have rated voltage (U_m) $\geq 72,5$ kV shall have requirement for transmitted overvoltage's as stipulated in SANS 61869-1 specification.

5.4.12 Corrosion

5.4.12.1 Caution has to be taken against corrosion of the equipment during the service life.

5.4.12.2 All bolted or screwed parts of the main circuit and of the enclosure shall remain easy to demount.

5.4.12.3 Galvanic corrosion between materials in contact shall be considered because it can lead to the loss of tightness. All these parts shall be galvanized as per CEE 0183 specification.

5.4.13 Markings

All instrument transformers shall carry at least the following markings on a rating plate securely attached to the transformer:

- a) The manufacturer's name or other mark by which he may be readily identified;
- b) The year of manufacture and a serial number or a type designation, preferably both,
- c) Rated frequency;
- d) Highest voltage of equipment;
- e) Rated insulation level;
- f) Temperature category;
- g) Mass in kg;
- h) Class of mechanical requirements (for $U_m \geq 72\text{kV}$).
- i) Class of insulation if different from Class A;

- j) All indications relative to the measuring characteristics;
- k) Type of the insulating fluid;
- l) Rated filling pressure;
- m) Minimum functional pressure;
- n) Insulating fluid volume (or mass) contained;
- p) the corresponding terminals of each winding.

6.0 QUALITY ASSURANCE

- 6.1 The manufacturer shall ensure a manufacturing process that is compliant with specification SANS 9001.

7.0 DOCUMENTATION REQUIREMENTS

- 7.1 The manufacturer must provide one PDF file and two hard copies of the technical specification of the current transformer.
- 7.2 The manufacturer must provide one PDF file and two hard copies of the installation procedure, these includes connection diagram with terminal and polarity markings.
- 7.3 Drawings showing details of construction and outline dimensions of the currents transformers shall be submitted with the tender documents.
- 7.4 The manufacturer must provide type test certificates from a SANAS/international accredited laboratory to verify conformance to the requirements and these must be submitted with tender documents.
- 7.5 The manufacturer must complete and provide technical data sheet as per Appendix B.

8.0 GUARANTEE AND DEFECTS

- 8.1 The contractor shall guarantee the satisfactory operation of the current transformers supplied and accept liability for maker's defects, which may appear in design, materials and workmanship.
- 8.2 The guarantee period shall expire after: - A period of 12 months commencing on the date of energising of the current transformers
- 8.3 Any specific type of fault occurring three times within the guarantee period and which cannot be proven to be due to other faulty equipment not forming part of this contract, shall automatically be deemed an inherent defect. Such inherent defect shall be fully rectified to the satisfaction of the maintenance manager of the depot and at the cost of the Supplier.
- 8.4 If urgent repairs have to be carried out by Transnet Freight Rail's staff to maintain supply during the guarantee period the supplier shall inspect such repairs to ensure that the guarantee period is not affected and should they be covered by the guarantee, reimburse Transnet Freight Rail the cost of material and labour.

9.0 SUPPORT

- 9.1 The supplier shall provide support whenever is required, this can be in a form of telephone or email communications and also a site visit.
- 9.2 Training and support shall be provided by the supplier if required.

10.0 PACKAGING AND TRANSPORT

- 10.1 The package shall have handling instructions on it.
- 10.2 The tenderer shall provide transport for the delivery of the equipment to the site where required.

END

SCHEDULE OF REQUIREMENTS (To be completed by client)

1.0 SYSTEM DETAIL

- 1.1 Current transformers required for: _____ substation/location.
- 1.2 Pollution level: Heavy _____ Very Heavy _____
- 1.3 Quantity of current transformers required. 2
- 1.4 Nominal phase to phase voltage for 3 phase system: 132 kV.
- 1.5 Nominal phase to neutral voltage for single phase systems: _____ kV.
- 1.6 Frequency: 50 Hz

2.0 DETAIL OF CURRENT TRANSFORMER.

MEASURING CURRENT TRANSFORMERS

- 2.1 Measuring current transformer required: ~~Yes~~ / No
- 2.2 Number of measuring cores required: 2
- 2.3 Transformer ratio: Primary 75 Ampere, Secondary 1 Ampere.
- 2.4 Rated primary current: 75 Ampere. Rated secondary current: 1 Ampere
- 2.5 Rated burden: 15 VA
- 2.6 Accuracy class: 0.5

PROTECTION CURRENT TRANSFORMERS

- 2.7 Protection current transformer required: ~~Yes~~/No
- 2.8 Number of protection cores required: 1
- 2.9 Rated primary current: 75 Ampere. Rated secondary current: 5 Ampere
- 2.10 Accuracy class: 10P10
- 2.11 Accuracy limit factor: 10
- 2.12 Rated Burden: 15 VA

CLASS PX PROTECTION CURRENT TRANSFORMERS

- 2.13 Class PX protection required: Yes/No
- 2.14 Number of Class PX protection cores required: _____
- 2.15 Transformation ratio: Primary _____ Ampere, Secondary _____ Ampere.
- 2.16 Rated primary current: _____ Ampere. Rated secondary current: _____ Ampere.
- 2.17 Rated turns ratio: _____
- 2.18 Rated knee point e.m.f: _____ V
- 2.19 Maximum secondary winding resistance: _____ Ohms at _____ ° C

END

TECHNICAL DATA SHEET
(To be completed by tenderer)

1.0 DESIGN DETAIL

- 1.1 Manufacturers name: _____
- 1.2 Highest voltage for equipment: _____ kV
- 1.3 Nominal r.m.s voltage: _____ kV
- 1.4 Rated insulation level: _____ kV
- 1.5 Rated frequency: _____ Hz

2.0 DETAIL OF CURRENT TRANSFORMERS.**MEASURING CURRENT TRANSFORMERS**

- 2.1 Transformer ratio: _____
- 2.11 Rated primary current: _____ Ampere. Rated secondary current: _____ Ampere
- 2.12 Accuracy class: _____
- 2.13 Rated Burden: _____ VA
- 2.14 Rated short-time current: _____ 40 _____ kA for _____ 1 _____ seconds

PROTECTION CURRENT TRANSFORMERS

- 2.15 Transformer ratio: _____
- 2.8 Rated primary current: _____ Ampere. Rated secondary current: _____ Ampere
- 2.16 Accuracy class: _____
- 2.17 Accuracy limit factor: _____
- 2.11 Rated Burden: _____ VA
- 2.12 Rated short-time current: _____ 40 _____ kA for _____ 1 _____ seconds

CLASS PX PROTECTION CURRENT TRANSFORMERS

- 2.20 Rated primary current: _____ Ampere. Rated secondary current: _____ Ampere.
- 2.21 Rated turns ratio: _____
- 2.22 Rated knee point e.m.f: _____ V
- 2.23 Maximum secondary winding resistance: _____ Ohms at _____ ° C
- 2.24 Rated short-time current: _____ kA for _____ seconds

END