Eskom	Standard	Technology

Title: **ANALOG OIL AND WINDING TEMPERATURE GAUGES FOR TRANSFORMERS AND REACTORS SPECIFICATION**

Unique Identifier:	**240-56063843**
Alternative Reference Number:	**41-621**
Area of Applicability:	**Engineering**
Documentation Type:	**Standard**
Revision:	**3**
Total Pages:	**8**
Next Review Date:	**Stabilised**
Disclosure Classification:	**Controlled Disclosure**

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PCM Reference: **Perform HV Plant Engineering**
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1. Introduction

Oil temperature indicators (OTI's) and winding temperature indicators (WTI's) are fitted to transformers to measure the oil and winding temperatures. The indicators do not only display the temperature but are also used to start / stop forced cooling, provide high temperature alarm and trip signalling.

2. Supporting clauses

2.1 Scope

This specification covers the technical requirements for the selection and purchase of temperature gauges fitted to Transformers and Reactors. The purpose of this document is to ensure that the requirements of these gauges are standardised within Eskom during the procurement stage.

This document shall be used as a minimum requirement for the purchase and selection of temperature gauges fitted to transformers and reactors.

- Temperature gauges fitted to new Transformers and Reactors
- Temperature gauges fitted to in-service Transformers and Reactors
- Temperature gauges purchased as Spare Parts

2.1.1 Purpose

This document was produced in order to record the standardized requirements that shall be applied across-divisional Transmission, Generation and Distribution.

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] ISO 9001, Quality Management Systems.

2.2.2 Informative

None

2.3 Definitions

2.3.1 General

None

2.3.2 Disclosure classification

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

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2.4 Abbreviations

Abbreviation	Description
°C	Degrees Celsius
kV	Kilo volts
m	Metre
mm/s	Millimetre per second
MVA	Mega Volt Ampere
OTI	Oil temperature indicator
UV	Ultra violet
WTI	Winding temperature indicator

2.5 Roles and responsibilities

Not applicable.

2.6 Process for monitoring

Not applicable.

2.7 Related/supporting documents

Not applicable.

3. Requirements

3.1 General

The instrument shall be mounted in the Marshalling Kiosk, where this is provided, otherwise, by means of an approved anti-vibration mounting on the transformer tank or separate stand. Stainless steel anti-vibration mountings and fasteners shall be used. Rubber or plastic mountings are not acceptable.

Sight glasses shall be tempered glass.

Expected design life of the OTI's and WTI's shall match the design life of a transformer, at least 40 years.

3.2 Environmental Conditions

Outdoor installation

Altitude above sea level – 1800 m

Ambient temperatures

- Maximum + 40°C
- Monthly average + 28°C
- Yearly average + 25°C
- Minimum – 10°C

Average relative humidity 90%

Solar radiation 2500 W/m²

Atmospheric UV radiation - High

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Seismic conditions at a maximum of 3g

Pollution level – High marine and industrial (C5)

3.3 Corrosion Protection

Corrosion shall be eliminated by the use, wherever possible, of non-corrodible materials, and by avoiding the contact of dissimilar metals.

Fasteners used shall be metric hexagon or Allen key type. All fasteners shall be stainless steel – grade 304 is acceptable. Electro galvanising or electro plating of parts and fasteners is not acceptable.

All capillaries shall be protected from external damage by using stainless steel spiral covering that extends from the gauge to the probe.

The complete casing shall be ventilated and have a protection class of IP55. Nitrile rubber shall be used as sealing material for “O” rings and flat rubber seals.

Each instrument shall be provided with at least 2 compression type glands for fitting control wiring. Cable entry shall be from the bottom of the instrument casing. Stoppers shall be provided to block the gland holes when not in use.

Thread lubrication shall be applied to all threaded areas on bolts, studs and screws. Any good quality high temperature grease is acceptable.

3.4 Probe Construction and Capillary Length

3.4.1 Transformers and Reactors < 1 MVA(r)

The connection between the probe and fitting shall provide an effective seal to keep water from entering the pocket.

Each temperature probe shall be supplied with 20 mm male threaded fitting. All fittings shall be manufactured from stainless steel or brass. The capillary length shall be 3 m.

3.4.2 Transformers and Reactors ≥ 1 MVA(r)

The seal between the temperature probe and fitting shall be in such a manner that the probe can be lengthened and shortened to suite specific pockets. The connection between the probe and fitting shall provide an effective seal to keep water from entering the pocket.

Each temperature probe shall be supplied with both 20 mm male and female threaded fittings. All fittings shall be manufactured from stainless steel. The temperature probe shall have uniform diameter of minimum 10 mm and maximum 15 mm along the full length. The probe length shall be adjustable to allow for installation in different depth probe pockets from minimum depth of 150 mm to a maximum of 300 mm.

To ensure minimum stock levels and maximum inter-changeability, four different temperature indicator arrangements shall be allowed:

- Oil temperature gauge with 6 m capillary
- Oil temperature gauge with 12 m capillary
- Winding temperature gauge with 6 m capillary
- Winding temperature gauge with 12 m capillary

3.5 Oil Temperature Measurement

Oil temperature indicators shall be installed on all Transformers and Reactors.

A dial-type thermometer displaying temperature over the full specified range, and unless otherwise approved, fully compensated for the effects of ambient temperature, shall be provided for registering the temperature of the transformer "top-oil".

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The instrument shall be fitted with a maximum temperature indicator, arranged for manual resetting, and with alarm signalling and tripping contacts, which can be manually set to close at predetermined temperatures.

It shall be provided with the following normally open contacts:

- 1 x normally open contact for alarm signalling
- 1 x normally open contact for trip signalling

3.6 Winding Temperature Measurement

Winding temperature indicators shall be installed on all Transformers and Reactors fitted with forced cooling systems or when specified in Schedules A & B.

Winding temperature thermometers shall be of the dial-type, unless otherwise approved, fully compensated for changes in ambient temperature, and shall have a load-temperature characteristic approximately the same as the hottest part of the windings. The current transformers for operating the thermometers shall be built into the main transformer tank and shall be located to reflect the maximum hot-spot temperature of the respective windings. For delta-connected windings, the current transformer shall be located electrically inside the delta connection.

For each loaded winding a separate winding temperature thermometer shall be provided, except in the case of two-winding transformers which shall be provided with a single winding temperature thermometer arranged to provide a thermal image of the maximum overall winding hottest-spot.

Thermometers shall be provided with dials indicating the temperature and fitted with a resettable maximum temperature indicator.

It shall be provided with the following normally open contacts:

- 1 x normally open contact for alarm signalling.
- 1 x normally open contact for trip signalling.
- 2 x normally open contacts shall be provided to automatically start the oil pump and/or fans for cooling the transformer.

The contacts shall be individually adjustable and self-resetting. The contacts shall be adjustable over the full temperature range of the indicator which can be set to close at predetermined temperatures. Alternatively, the start signalling may be derived from a current relay with suitable hysteresis characteristics to avoid hunting.

Unless otherwise approved, the operation of the winding temperature thermometer shall not require any external electrical power supply.

Terminals and links shall be provided in the Marshalling Kiosk or, where provided, the cooler controller cabinet for checking the output of the current transformer and/or the functioning of the heater coil by means of an external supply.

3.7 Remote Temperature Monitoring

The control of networks requires the remote indication of oil and winding temperatures. For this purpose, all temperatures indications shall in addition to the above local indicators which must work without auxiliary supply, also be made available in the transformer control cabinet in a format suitable for interfacing with modern SCADA systems.

The information shall be provided as **4-20 mA** signals. This is a requirement on transformers and reactors rated 1 MVA(r) and above.

3.8 Alarm, Control and Tripping Contacts

Alarm and tripping contacts shall be provided with electrically independent and unearthed circuits and shall be insensitive to vibration and earth tremors. This insensitivity shall not depend on the method of mounting but shall be an inherent feature of the contact assembly. Mercury micro switches are not acceptable.

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Manual operation of the alarm, control and tripping contacts shall be possible without having to disconnect wiring or short contacts. Test button(s) shall be provided for this purpose.

Temperature selections shall be adjustable and micro switches rated for 0.25 A at 220 V DC.

The indicator circuits shall withstand an applied voltage of 2 kV DC for 60 seconds, applied in turn, between each electrically independent circuit and the casing of the instrument, and between the separate independent electrical circuits.

All terminal boxes shall be provided with an earth connection point and shall be effectively earthed.

3.9 Temperature Range and Display

The temperature range shall be clearly marked with temperature displayed in 10°C increments. Additional indications shall be provided in with a maximum increment of 2°C – these shall not be numbered. The temperature range shall be displayed from 0°C to 140°C for units rated at 1 MVA(r) and above and from 0°C to 120°C for units rated below 1 MVA(r).

The graduations shall be on the inner indication plate and not on the sight glass.

The display shall be clear and easily readable from 2 metres. The alarm, trip and cooling control settings shall be visible without having to dismantle the instrument.

NB: In the event of the capillary being severed the temperature indicator pointer shall fall to zero and remain there to provide visual indication that the gauge is defective.

3.9.1 Documentation and Packaging

A standard test card bearing the manufacturer's serial number of the temperature gauge shall be included with each of the operating instruction manuals required for the gauges. Each gauge shall be supplied with a calibration certificate and all relevant test information as required by this document.

Original and fully detailed instructions for assembly, operation, testing and maintenance of the gauge shall be included with each relay. The gauge shall be securely packed and properly protected against damage and moisture ingress during shipping and storage.

Each gauge shall be individually packed inside a cardboard box. Each package shall include a male and female 20 mm fitting – stainless steel only. Gauges shall be provided with all fasteners and brackets for installation.

3.10 Technical Evaluation and Final Approval

The OEM / Supplier shall be responsible to supply a WTI and OTI for technical evaluation. The equipment shall be supplied to Eskom and will be subjected to destructive testing. The sample shall be supplied in accordance with this specification, and it will remain the property of the supplier.

This specification serves as a minimum requirement for manufacturers that supply temperature gauges. Any deviation from this specification must be approved by Eskom in writing before ordering or manufacturing of the relay.

Final written approval shall be provided once a technical evaluation has been completed and equipment found in compliance with this specification and Eskom requirements.

Any changes to the approved product will be subjected to re-evaluation and approval.

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4. Authorization

The stabilisation of this document was seen and accepted by the following experts:

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5. Revisions

Date	Rev	Compiler	Remarks
April 2024	3	M. Hlakudi	Document stabilised with updates on corrosion requirements.
Feb 2018	2	M. Ngubane	Upgraded corrosion resistance application and new micro switch ratings
Sept 2009	1	A Smit	Document revised to cater for Gx, Tx and Dx requirements.

6. Development team

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

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7. Acknowledgements

Final document compiled by Generation, Transmission and Distribution

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