

	Standard	Technology
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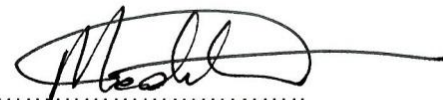


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1. INTRODUCTION

In order to attain a cost effective maintenance programme, it is necessary to know the condition of large power transformers at all times. In-service tests, such as oil sampling and analysis and application of on-line monitoring equipment, provide valuable information on the state of various components, while off-line testing is still regarded as providing the information most likely to enable a firm decision. Often, it is the use of a combination of various techniques, which lead to an accurate diagnosis. There are many visual and physical checks that can also be performed, that would give an indication of the transformer status. These checks are termed Hand Condition Monitoring, and are inspections conducted on a periodic basis, without the need of specialised skills or equipment.

2. SUPPORTING CLAUSES

2.1 SCOPE

2.1.1 Purpose

The document outlines aspects to be considered in the overall condition assessment of large power transformers. It must be used as a check-sheet, to be used in the periodic observation of various parameters and conditions of the plant.

2.1.2 Applicability

This document is applicable to all Generation Power Stations. It should be implemented on all large power transformers. This standard is additional to any other tests that are normally carried out on large power transformers and is not meant to replace them.

This document shall apply throughout Eskom Holdings Limited Divisions.

2.2 NORMATIVE/INFORMATIVE REFERENCES

References to the following document(s) will enhance the understanding of the reader on the subject covered in this document. The requirements of these document(s) are, however, not an extension of this document.

2.2.1 Normative

None

2.2.2 Informative

[1] **GST 36-356**: Health care of large power transformer within generation

2.3 DEFINITIONS

Definition	Description
Large power transformers	Refers to Generator transformers, Unit, Service and Station transformers

2.3.1 Disclosure Classification

Controlled Disclosure: Controlled Disclosure To External Parties (either enforced by law, or discretionary).

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2.4 ABBREVIATIONS

Abbreviation	Description
OEM	Original Equipment Manufacturer

2.5 ROLES AND RESPONSIBILITIES

None

2.6 PROCESS FOR MONITORING

None

2.7 RELATED/SUPPORTING DOCUMENTS

None

3. TRANSFORMER HAND CONDITION MONITORING STANDARD

Every site is required to compile a site specific procedure utilising Appendix A in this document and planned maintenance process for the monthly planned inspections.

The inspections shall be performed as a minimum on a monthly basis however the transformer system engineer can increase the frequency depending on the performance and experience of the respective Power Station's large power transformers

3.1 SAFETY

3.1.1 Tools

- Hand held infra red thermometer
- Binoculars

3.2 METHODOLOGY

The inspection consists mainly of visual observations on transformer instrumentation and physical conditions around the transformer. A permit to enter the transformer yard or enclosure shall be obtained and all necessary safety regulations adhered and complied to.

3.2.1 An assigned person shall be responsible for:

- All breathing apparatus and dry-out equipment is dry, that there are no obstructions and shall be maintained in a working condition according to the OEM manuals. A general rule is that less than 30 % of the silica gel shall be pink.
- The conservator tank oil level shall be within the limits specified by the OEM. The level and the amount of top-up oil used shall be recorded.
- The fire protection system shall be visually inspected for any defects, and that the nozzles point in the correct direction.
- The main tank, tap changer tank, pipe work, bushings and other parts shall be checked for oil leaks. A record shall be kept of any leakage.
- Check for abnormal sounds in fans, pumps, motors, and the transformer.

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- f. Check (use binoculars if necessary) and record the bushings for cracked or chipped insulator sheds, oil level, pollution levels and condition of grease where applicable.
- g. Check all temperature devices, recording the readings and the maximum indication readings. Reset maximum indicators and also record the tap changer tank surface temperature.
- h. Inspect and record and rust spots or corrosion
- i. Open the control cubicle and visually check wiring, components, signs of water ingress. And that the heater is operational. Record any abnormalities.
- j. Inspect (use binoculars if necessary) the arresters for a sound connection of the earth lead and HV lead and for any damage to the insulator sheds.
- k. Check each heat exchanger for cleanliness, free from obstructions, correct valve positions, correct temperatures, air flow, in and outlet temperatures. Check that the heat is being evenly radiated from the coolers. Care shall be taken when starting pumps and fans so as not to create the conditions where a static discharge may take place.
- l. Record the tap changer counter readings, tap changer tank oil temperature, any incidents of tap changer automatic lockout, alarms and transformer running hours.
- m. Open the tap changer control box and visually check the wiring, components, tap position marker indicating correct positioning of the mechanism when fully positioned, the heater is functional and check for any signs of water ingress.
- n. Record any abnormal conditions the transformer has been subjected to during the period from the previous inspection such as overloading, high through faults and overfluxing.
- o. Visually check all pressure relief devices for oil leaks or defects.

3.2.2 An assigned person shall be responsible for:

- a. Use of complete the pro-forma check-sheet
- b. the inspections on large power transformer
- c. the accurate recording of the various parameters and observations
- d. Tap changer and cooler condition are assessed by the noting of differential temperatures, which are to be taken using a hand-held infra-red thermometer supplied for the purpose.
- e. The delivery of the completed check-sheet to the transformer system engineer.

3.2.3 The transformer system engineer shall be responsible for:

- a. Check and analyse the check-sheet data and take appropriate actions if necessary (e.g. load notifications for maintenance activities)
- b. Comparison of recordings (e.g. comparing the temperature recordings of the tap changer compartments to that of the main tank)
- c. Store data in electronic database for trending purposes
- d. Archiving the check-sheet for recording and maintenance planning purposes.

3.3 RECORDS

The check sheet of the referenced serial number of the transformer shall be indexed, maintained and filed such that it can retrieve as required. These records must form part of the transformers history book for record of evidence for the life of the station.

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4. AUTHORISATION

This document has been seen and accepted by:

Name & Surname	Designation
	Document Approved by TDAC ROD 13 February 2013

5. REVISIONS

Date	Rev.	Compiler	Remarks
November 2012	0	EJ Mbokodo	Draft Document for Review created from GST 36-77
May 2013	1	EJ Mbokodo	Final Document for Publication

6. DEVELOPMENT TEAM

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

- None

7. ACKNOWLEDGEMENTS

- None

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APPENDIX A: HAND CONDITION MONITORING CHECKLIST

TRANSFORMER ID :

SERIAL :

GEN MW @ time of check:

MW

PERFORMED BY :

DATE :

SIGNED :

SECTION 1**Temperature**

Ambient Air Temperature

Winding Temperature Actual

Top Oil Temperature Actual

Winding Temperature Maximum

Pointer

Top Oil Temperature Maximum

Pointer

Calculated Hot Spot Temperature Rise **Note 1**

Hot Spot Temperature > 110°C

Tap Changer Temperatures (°C)

Note 2

Main Tank Temperatures (°C)

Calculated Temperature difference

Note 3

Any High Tap Changer Temperature

	°C		
	°C		
	°C		
	°C	Reset	Yes
	°C	Reset	Yes
	°C		
Yes	No		
A Phase B Phase C Phase			
Yes	No		

SECTION 2 (Note 4)**Bushings**

Oil Level

Line / Pointer

Cleanliness of the level gauge glass

Oil visible

Cracks, Chips and sweating

Visual check

Below	On	Above
No	Yes	
Yes	No	

Conservator tank

Conservator Oil Level (Main Tank)

Visual check

Conservator Oil Level (Tap Changer)

Visual check

Oil Leaks

Visual check

Cleanliness of the gauge glass

Oil Visible

Valves sweating

Visual check

Min	Max	Temp	
Min	Max	Temp	
Yes	No		
No	Yes		
Yes	No		

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Bucholtz leaks

Visual check

Yes	No
-----	----

Cooling system

Cleanliness of the radiators

Dust/Obstructions

Yes	No
-----	----

Heat distribution

Hot air outwards

No	Yes
----	-----

Rust on radiators/fins

Visual check

Yes	No
-----	----

Oil flow switch and leaks

Visual check

Yes	No
-----	----

Oil pump direction

As indicated

No	Yes
----	-----

Valves, pumps sweating

Visual check

Yes	No
-----	----

Efficiency of the radiators

Note 5

Inlet	Outlet
-------	--------

Radiator 1

Degrees Celcius

--	--

Radiator 2

Degrees Celcius

--	--

Radiator 3

Degrees Celcius

--	--

Radiator 4

Degrees Celcius

--	--

Calculated Temperature Differences

Rad 1	Rad 2	Rad 3	Rad 4
-------	-------	-------	-------

Degrees Celcius

--	--	--	--

Outlet < 5OC lower than Inlet (Any)

Yes	No	
-----	----	--

Silica breather

Silica Gel (2 canister system) small

Colour

Pink	Blue	Other
------	------	-------

Silica Gel (1 canister system) > 30%

Colour

Pink	Blue	Other
------	------	-------

Oil seal bowl

Oil filled

No	Yes	
----	-----	--

Transformer main tank

Oil leaks on gaskets

Visual check

Yes	No	
-----	----	--

Earthing connections solid

Visual check

No	Yes	
----	-----	--

Rust

Visual check

Yes	No	
-----	----	--

Tap changer

Oil Leaks

Visual check

Yes	No	
-----	----	--

Locked

Visual check

No	Yes	
----	-----	--

Counter Reading

--	--

Surge arrestors

Obvious damages

Visual check

Yes	No	
-----	----	--

Connection of earth mat

Visual check

No	Yes	
----	-----	--

Pollution

Visual check

Yes	No	
-----	----	--

Marshalling kiosk & junction boxes**CONTROLLED DISCLOSURE**

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Dust	Internal	Yes	No
Door seal	Intact	No	Yes
Labeling of temperature indicators	Present	No	Yes
Any hot connections	Note 2	Yes	No

Online DGA device

Status (power on/off)	Visual check	Yes	No		
Oil leaks (on the unit)	Visual check	No	Yes		
Oil leaks (piping)	Visual check	No	Yes		
Alarm status	Visual check	Service	Caution	Alarm	None

Bundwall / Oil catchment area

Blockages	Visual check	Yes	No
Cleanlines of the bundwall area	Visual check	Poor	Good

Fire protection system

Valves / other leakages	Visual check	Yes	No
Bulbs	All intact	No	Yes
Nozzles	All intact	No	Yes
Position of valves	Visual check	Closed	Open

Bundwall / Oil catchment area

Blockages	Visual check	Yes	No
Cleanlines of the bundwall area	Visual check	Poor	Good

General

Availability of name plate	Visual check	No	Yes
Labeling of sampling points	Visual check	No	Yes
Cable entries to be water tight and secured	Visual check	No	Yes
Unusual noise from the transformer	Acoustic check	Yes	No
Noise from fans	Acoustic check	Yes	No
Noise from pumps	Acoustic check	Yes	No
Noise from main tank	Acoustic check	Yes	No
Noise from tap changer	Acoustic check	Yes	No

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NOTES :

Note 1 : The sum of Ambient Temperature and Winding Temperature should not be higher than 110°C.

Note 2 : Hand-held infra-red scan of each tap changer compartment outer wall and of the main tank wall nearest to each phase tap changer and at least 2M from ground level. Suggested equipment – RAYTEC Raynger ST6 or similar. Can also be utilised to check for any hot connections inside marshalling kiosk.

Note 3 : Deduct the tap changer temperature from the main tank temperature. Result should be a positive value.

Note 4 : Section 2, any LEFT SIDE block (shaded) checked, indicates a potential problem, requiring further investigation.

Note 5 : Hand-held infra-red scan of the main supply and delivery oil pipes for the external radiators (measured closest to the radiators). Calculated temperature difference (Inlet – Outlet) should be a positive value. The temperature will be different for an energised unit to a fully loaded one. It is estimated that on a loaded transformer the difference should be of the order of 5OC, while for an off load transformer, the difference is more likely to be higher. It is recommended that the temperature checks be made with the transformer on load.

Suggested equipment - RAYTEC Raynger ST6 or similar.

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