Eskom National Transmission Company South Africa ™	**Standard**	**National Transmission Company South Africa**

Title: **FUNCTIONAL SPECIFICATION FOR THE ONLINE VIBRATION MONITORING SYSTEM ON OIL FILLED HV REACTORS**

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Content

Page

1. Introduction

The National Transmission Company South Africa (NTCSA) network has an installed base of oil-filled series, shunt and smoothing reactors. A number of oil-immersed gapped core shunt reactors in the network have been reported to be excessively vibrating, eventually resulting into in-service failures.

Vibration tests are conducted on the reactor periodically to determine the level of vibrations. There is no continuous monitoring in between the manual testing interventions. This hinders early fault detection, limits predictive maintenance strategy and increases the risk of unexpected failures. A blind spot on the health status of the reactor therefore leads to elevated safety and operational risks, resulting in costly maintenance.

A suitable online vibration monitoring solution for high-voltage (HV) reactors is required to achieve effective asset management. The purpose of the system is to provide continuous, real-time monitoring of reactor vibrations, including trending and alarming. It is not intended to replace periodic vibration tests but rather to supplement them.

2. Supporting Clause

2.1 Scope

This document specifies the functional requirements for an online vibration monitoring system to be installed on oil-filled HV reactors in the NTCSA network.

2.1.1 Purpose

To keep records of the above scope.

2.1.2 Applicability

This document shall apply throughout National Transmission Company South Africa SOC Ltd Reg No 2021/539129/30.

2.1.1 Effective date

From date of authorisation.

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] 240-60725684: Specification for oil immersed HV and EHV Power Reactors

[3] IEC 60076-6: Reactors

[4] IEC 60529: Degrees of Protection Provided by Enclosures (IP Code)

[5] IEC 62443: Industrial communication networks – Network and system security

[6] IEC 61850: Communication networks and systems for power utility automation

[7] IEC 61010: Safety requirements for electrical equipment for measurement, control, and laboratory use

2.2.2 Informative

None

2.2.3 Definitions

Definition	Description
Functional Specification	A document that outlines the expected functions of a system from the user or system perspective, stating what it must achieve without prescribing the detailed technical implementation.
Series Reactor	An inductor (coil of wire) connected in series with a network to provide inductive reactance that limits/reduces fault current to within safe limits during short circuit conditions, ensuring that the ratings of other equipment are not exceeded.
Shunt Reactor	Static electrical device connected in parallel with a transmission line or busbar to absorb excess capacitive reactive power generated by long-distance transmission lines. The power frequency overvoltage under low load conditions (a phenomenon known as the Ferranti Effect) is limited through reactive power consumption. This in turn optimises a transmission line's capacity for active power transfer with minimal loss, thereby increasing the network energy efficiency and power quality.
Smoothing Reactor	An inductor connected in series with a DC network after a rectifier, to oppose sudden changes in current in order to reduce ripple voltage and current, producing smooth and stable DC for the load.

2.2.4 Classification

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

2.3 Abbreviations

Abbreviation	Description
AC	Alternating Current
CR	Corrosion Resistant
DFT	Dry Film Thickness
HV	High Voltage
IEC	International Electrotechnical Commission
IP	Ingress Protection
NTCSA	National Transmission Company South Africa
OEM	Original Equipment Manufacturer
Peak-to-Peak	P – P
SCOT	Steering Committee of Technologies
SE&D	Substation Equipment & Diagnostics
VL	Vibration Level
UV	Ultraviolet Radiation

2.4 Roles and Responsibilities

The **Bid Evaluation Team** must ensure that the minimum requirements stipulated in this document are adhered to.

2.5 Process for Monitoring

The relevant **SCOT Care Group** shall evaluate the document and its relevance every five (5) years or when deemed necessary.

2.6 Related/Supporting documents

None

3. Requirements

3.1 General

The system must be able to operate optimally (and without damage) within the substation environmental conditions as defined under clause 3.2. Its design lifespan is anticipated to match the expected reactor service life of at least 40 years when utilized and maintained according to the original equipment manufacturer (OEM) manual. All components of the system shall be housed in an ingress protection (IP) 65 rated enclosure/casing. The system and its components must comply with cybersecurity requirements where applicable to protect data integrity, confidentiality and availability. It must also not impede or compromise the safe operation of the reactor or the safety of personnel in the vicinity.

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 kWh/m².
- Atmospheric UV radiation – High.
- Seismic conditions at a minimum of 0.3g.
- Pollution Level – High marine and industrial (C5).

3.3 Functional Requirements

The system shall, at a high level:

a) Continuously measure and record vibration data from sensors mounted on the reactor main tank under all operating conditions, including correct timestamping. The vibration data measured by each sensor shall be displayable.

b) Permanently store the recorded data locally and transmit it to a portable engineering laptop or any other relevant local display. A modelled live display functionality shall be included.

c) Provide web access to vibration data.

d) Generate validated warnings with push SMS notifications when vibration levels exceed predefined thresholds. Vibration thresholds shall be configurable by the user.

e) Comply with applicable cybersecurity requirements.

f) Include self-diagnostics for sensor and cable integrity.

3.3.1 Measurement Capability

a) The system must be able to measure vibration displacement amplitudes up to at least 500 µm peak-to-peak (p-p).

3.4 Power Supply

a) The system must be powered by easily available source of power, preferably long-lasting built-in batteries or AC supply.

3.5 Packaging and Storage

a) The system shall be securely packed and protected against damage, ingress of moisture and dirt during shipping and storage, with all ports suitably sealed.

3.6 Installation

a) Transducers or equivalent measuring devices must be mountable on the side walls of reactor tanks and remain attached under severe vibrations.

b) Training which includes installation, commissioning, operation, maintenance and decommissioning must be provided to responsible engineering personnel during system installation.

3.7 Technical Support

a) The supplier must provide on-going technical and maintenance support to ensure reliable system performance preferably throughout its service life but at least five (5) years after first commissioning.

3.8 Documentation

a) OEM user manual will be required with the bid submission.

3.9 Technical Evaluation and Final Approval

NTCSA will evaluate the proposals as per the provided technical evaluation criteria. Further negotiations and award shall be with top ranking proposals, as calculated from the submissions using the scoring criteria. There is no hard fail or pass but proposals that are most aligned to NTCSA requirements will be prioritized.

4. Acceptance

This document has been seen and accepted by:

Name	Designation
Bheki Ntshangase	Senior Manager – Asset Management SE&D
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5. Revisions

Date	Rev.	Compiler	Remarks
February 2026	1	T.I. Khanye	Original Document

6. Development Team

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

- Sidwell Mtetwa
- Thato Khanye

7. Acknowledgement

SE&D Transformers and Reactors section colleagues for their valuable input.