Eskom	**SPECIFICATION**	**Transmission/**

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1. Introduction

Transformer maintenance standards and procedures stipulates that transformers must be tested prior to commissioning after fault trips and during maintenance intervals. prior to energising the installations. It is critical that the test equipment used to perform these tests is as robust, reliable, practical, and cost-effective as reasonably possible.

However, it should be noted that the risk of inadequate test equipment being procured is not removed but is reduced from the situation where there is no specification until the time where an industry specification is available.

2. Supporting clauses

2.1 Scope

These standard covers transformer test equipment specification. This specification covers the general and standard requirement, technical data design, supply, delivery, and training.

The transformer testing set up shall be fully automatic.

The Hardware & Software connectivity for test instruments with PC & printer for further processing to generate inputs & reports.

The transformer test equipment up shall be capable for testing of all routine test and other tests as stated in this specification.

The transformer test equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation, in a manner acceptable to purchaser, who will interpret the meaning of drawings and specification and shall have the power to reject any work or material which, in his judgment is not in accordance therewith. The offered material shall be complete with all components necessary for their effective and trouble-free operation. Such components shall be deemed to be within the scope of Supplier's supply irrespective of whether those are specifically brought out in these specifications and / or the commercial order or not.

2.2 Applicability

This document shall apply only in North East Grid HV plant department

2.3 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.3.1 Normative

[1] ISO 9001: Quality Management Systems.

[2] Eskom Standard 240-76624513, "Standard for the calibration of test instruments used by field staff".

2.3.2 Informative

[19] ISO/IEC 17025, "General requirements for the competence of testing and calibration laboratories".

2.4 Definitions

2.4.1 General

Definition	Description
True r.m.s.	Measurement of voltage or current whereby the r.m.s. value can be accurately determined irrespective of the waveform of the voltage or current being measured.

2.4.2 Disclosure classification

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

2.5 Abbreviations

Abbreviation	Description
A	Amperes (Amps, unit of current)
a.c. / AC	Alternating Current
d.c. / DC	Direct Current
Hz	Hertz, unit of frequency
IEC	International Electrotechnical Commission
R.M.S.	Root mean square
V	Volts (unit of voltage)

2.6 Roles and responsibilities

2.6.1 Supplier

The supplier shall furnish the purchaser with proof of compliance with this standard, e.g. letter of conformity.

2.6.2 Purchaser

The purchaser shall verify the practical aspects of each submission, e.g. connection to ready boards and socket outlets and inclusion of probes, batteries and battery chargers – i.e. those that do not require testing to verify.

2.7 Process for monitoring

Not applicable.

2.8 Related/supporting documents.

Not applicable.

3. Type of test equipment required.

3.5 Required test equipment

The following test equipment shall be procured:

- Three phase Transformer resistance meter
- Three phase Sweep frequency response analyser
- Three phase transformer turns ratio tester

3.6 Combining of test equipment

Test equipment that combines some or all of these functions into one item of equipment is also allowed, but each function shall meet the requirements of this standard.

4. Mandatory requirements

4.1 The supplier shall be an original manufacturer / sole authorized dealer / accredited representative of manufacturer of the tendered item. In case of dealers / authorized representative, an authorization letter for quoting in this tender with mentioned tender no. shall be obtained from original manufacturer & shall be submitted along with this bid.

4.2 In case the supplier is not an original manufacturer, the operating experience of the bidder shall be more than 5 years for supplying and providing after sales support of similar or better equipment.

4.3 The supplier should have a valid ISO 9001 & ISO 14001 certification.

4.4 The supplier should submit minimum 5 Job Completion

4.5 The manufacturer must have experience of minimum five years in supplying transformer test equipment to Utilities. The manufacturer shall enclose necessary purchase order copies along with their bid to prove the same.

4.6 Supplier or their principals shall have fully equipped technical support office / laboratory for facilities of testing, calibration, adjustment, diagnosis, and repair of equipment's in South Africa itself.

4.7 The Bidder or their principals shall have their own service centres and trained engineers dedicated for trouble shooting and technical support permanently posted in South Africa.

4.8 The supplier shall enclose necessary proof that the firm / the manufacturer / the principal the supplier is participating for, has necessary facility to adjust and calibrate the offered measuring units within the country.

4.9 The offers of South African subsidiary company, whose parent company is located abroad fulfilling the qualifying requirements as above, shall be considered provided the South African participant subsidiary company fulfils the minimum experience of one year of supply or manufacturing of similar or better equipment's to National / International accredited laboratories or power utilities. However, the conditions of turnover and supply of minimum quantity of similar or better equipment's to National / International accredited laboratories or power utilities as brought out elsewhere in tender documents can be fulfilled by the parent company located abroad on behalf of their South African subsidiary company.

4.10 The parent company shall furnish undertaking for accepting responsibility for supplying quality equipment's as per specifications and execution of the contract on behalf of its South Africa

5. Environmental Conditions

The transformer testing set up to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions: **Environmental Conditions**

a) Maximum ambient temperature 55^0 C

b) Minimum ambient temperature -10^0 C

c) Maximum ambient temperature of air in shade 50^0 C

d) Minimum temperature of air in shade 35^0 C

e) Maximum daily average temperature 40^0 C

f) Maximum yearly weighted average temperature 32^0 C

g) Maximum altitude above mean sea level 1800 meters

h) Climate: Moderately hot and humid tropical climate conducive to rust and fungus growth.

6. Construction and General Technical requirements

6.1 The transformer testing set up shall be capable for testing three phase and single-phase power Transformers, Auto transformer up to 765kV

6.2 There should be Data logging software with features like data acquisition, and test report development and generation with data/report archiving.

6.3 The software provided should also be capable of data analysis based on user set points.

6.4 The supplier should Supply the necessary interface hardware and appropriate for the system.

6.5 The equipments viz. Insulation resistance tester, Transformer turn ratio meter, Power Analyzer Computer & HMI shall be panel mounted & fixed on the front side of the test bench.

6.6 All the instruments fully automatic

6.7 The supplier shall provide all the software / drivers for all the instrument free of cost.

6.8 **Temperature**

The specified operation range shall be -10^0 C to +55^0 C

6.9 **Frequency**

The rated frequency shall be 50 Hz with a tolerance of ± 5%

6.10 The testing instruments & equipment included in the offer should be of reputed make.

6.11 All the equipment used shall be of very high quality and most dependable and designed with proper safety margin to carry the necessary electrical parameters like current, voltage and power for continuous use throughout year and proper protection to trip under any abnormality. The test system is likely to be used round the clock.

6.12 All the measuring & testing instruments should be latest calibrated and the calibration certificates should be provided along with the supplies. All the major equipment will also carry test reports as per the standards

6.13 In Software, data acquisition from various test instruments should be happen without any human intervention. The software validation should be done by the supplier.

6.14 The Software should have user interface that acquires on-line data from test instruments to generate test reports with auto indexing and page numbering. It should consist of an option of manual data entry too. The software can be used in the automatic mode for acquiring data from test instruments with the click of a mouse or data from a test instrument can be read and entered in the software manually.

6.15 The Software should have facility to provide for multiple, user defined permutations and combinations based on the type of a transformer, type of phase, type of winding, type of cooling, various rated capacities, various vector connections, and tap changers.

6.16 The Software should have easy storage, data retrieval; data analysis capability ensures error-free complex calculations facility.

6.17 In addition to the detailed report format, the software should have the short report facility which gives the report of the routine test to avoid the unnecessary paper wastage. The Software should have the database backup facility to take the backup of database in the hard drive.

6.18 Software should have facility to export data in other formats such as MS excel/MS word /PDF for further analysis.

6.19 The Software should have the facility of printing formula sheet on demand.

6.20 The Software should have the facility to generate MIS reports by selecting a specific period, customer, KVA Rating, and the inspection type.

6.21 The transformer test equipment up shall be designed and constructed in such a way as to avoid introducing any danger in normal use and under normal conditions, so as to ensure especially:

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6.32 The Software should have the facility to generate MIS reports by selecting a specific period, customer, KVA Rating, and the inspection type.

6.33 The transformer test equipment up shall be designed and constructed in such a way as to avoid introducing any danger in normal use and under normal conditions, so as to ensure especially:

(a) personal safety against electric shock:

(b) personal safety against effects of excessive temperature.

(c) protection against spread of fire;

(d) Protection against penetration of solid objects, dust & water in meter.

6.34 All parts that are likely to develop corrosion under normal working condition shall be effectively protected against corrosion by suitable method to achieve durable results. Any protective coating shall not be liable to damage by ordinary handling nor damage due to exposure to air, under normal working conditions.

6.35 All the cords / connectors / accessories supplied along with the instrument must conform to the international standards of safety. Adequate built-in features to protect the instrument itself from overvoltage shall be provided.

6.36 The transformer test equipment up shall also have interface to an external printer through PC software.

6.37 **Shock and Vibration protection**

The equipment must be immune to Vibration and dumping due to transport.

Suitable transportation case shall be provided along with the equipment.

6.38 **The test equipment software should have the following**

- The software should provide facility to test transformers of all vector groups by choosing appropriate option:

  The software should provide facility to test single phase or three phase & two winding or three winding transformers
- The software should provide the selection of transformers with tap changer or without tap changer
- While testing winding resistance there should be facility to present results in units such as ohms or mili-ohms. Calculation in load loss test should take account of unit selected during winding resistance test.
- For voltage ratio test report error in % should be provided.
- Software should provide user editable acceptance criterion for voltage ratio test
- For no load loss test watt meter constant entry should be available
- The software should provide error free calculations
- The software should maintain log for delete option
- The software should have data backup facility
- Software should provide facility to export data in other formats such as MS excel for further analysis
- Software should have user friendly graphical interface.
- Software should acquire data form temperature scanner and generate cooling curve graph and do all the calculation automatically
- Software should have facility to lock the data so no intervention after completion of tests

6.39 Accessories/Equipment to be supplied with the test equipment

6.39.1 For performance of testing

- All test equipment shall be supplied with all accessories required to perform testing, including but not limited to probes, cords and plugs.

6.39.2 Batteries and battery chargers

- All test equipment shall be supplied with the batteries required to operate the equipment, either integral to the equipment (built-in) or removable. Chargers for the batteries shall also be supplied and shall plug into standard South African socket outlets as defined in SANS164-1 [7].

6.40 Capabilities of equipment supplier

- All test equipment shall be supplied by a local supplier who is able to perform the calibration in accordance with Eskom requirements and is also able to service and repair damaged equipment in a timeous and cost-effective manner.

6.41 Training and Guarantee

- The cost of training for the test equipment shall be Included In the tendered price, Training shall be performed by a local highly qualified and experienced engineer. The test equipment shall be guaranteed for minimum 12 months.

7. Technical requirements specific to Three phase Transformer resistance meter

7.1 Application

- The test equipment shall measure resistance of inductive devices, such as transformers and power inductors. It has the features of fast measurement, small size and high accuracy of measurement, which is ideal equipment of measuring transformer winding and resistance of big power inductance equipment.
  - Perform three phase test on a transformer without the need to switch cables
  - Prorovide individual Delta winding resistance values
  - Demagnetize transformer after test

7.2 Connection to concentric service cable

- The test equipment shall be able to connect reliably and safely to on the bushings.

7.3 Numerical display

- The test equipment shall have a numerical display that clearly and unambiguously displays the value of the measured insulation resistance.

7.4 Test Modes

.Parameter	Requirement
Input	230V/50HZ
Test range	10A :20Ω,200Ω 0.1A: 2000 Ω 0.01A:2000 Ω
Resistance range	1micro-ohm - 2,000 ohms
Minimum resolution	0.0001
Accuracy	1 - 19,999 micro-ohms: ±0.5% reading, ±1 count 20 - 999 milliohms: ±1% reading, ±1 count 1 - 2,000 ohms: ±1.5% reading, ±1 count
Output voltage	Max 35V/50Hz
Testing times	≥800 times (quick mode)
Storage data	100 sets
Temperature in operation	-10℃ to 40℃
Relative humidity	≤90%, No dew
Dimensions	53cm X 43cm X 24cm
Net weight	16Kg Max
Display Full Graphics	LCD module, adjustable back-lighting, wide temperature range, 128 x 64 dots (21 characters by 8 lines) viewable in bright sunlight and low-light levels

8. Technical Specification of Three phase sweep frequency response analyser (SFRA) testing kit

8.1 Application

- The test set should be fully automatic and suitable for measuring on three phases (two winding & three winding) & single-phase Power Transformers up to 765 kV,666 MVA rating & Rectifier transformer of 100 kA current rating.

  The test equipment shall have the ability to cover most important diagnostics area:

  a) Core and magnetic properties

  b) Winding movement and deformation

  c) Interconnections (leads and tap-changers)

8.2 Special feature,

- Offered SFRA kit should have following features:

d) High measurement reliability and reproducibility.

e) High signal to noise ratio

f) Automatic interpretation according to applicable standards

g) Rugged, lightweight and small

h) Measuring Modes- Amplitude & phase

i) Ease to use

j) Analysis tools — Measured transfer function curves should be displayed as Magnitude (dB), phase (0), Impedance (Q) and Admittance (S), user defined.

k) Report generation from the measured data file or from any analysis data files.

l) Data export- measured file should be stored in XML format & CSV (comma separated values) format and should directly . opened in Microsoft Excel.

8.3 Measurements

m) Active probes designed for high reproducibility user interface built in Touch screen Active probe

n) Built in PC, Software running under Window XP embedded.

o) External PC software- Window

p) Field proven designed, rugged and light weight (10kg Approx.) and dimension 40x30x15 cm

Frequency: 10 Hz to 10 MHz Max, User defined

Voltage output: Max 12Vpeak-peak at 50 Q and Max 24Vpeak-peak at IMQ, user defined

Input Impedance: Selectable 50 Q or 1 MO

Output Impedance: 50 Q

Accuracy: ±0.1 dB, Zero Calibrated

Dynamic range: >100dB

Measuring Points: Max 2000, user defined, logarithmically s aced

Protection: Against short circuit, Overload

8.4 Data display

Scaling: Logarithmic or Linear, user defined

Frequency Range: 10 Hz to 10 M Hz Max, User defined.

Plot, Frequency Vs: Magnitude, 1m impedance, Phase, Admittance

Processor: Celeron M, IGHz or better

Data Storage: 40GB Hard Disk or better

RAM: 256MB or better

Display: 10.0", Color TFT or better

Interfaces: USB 2.0 2, RS232

User Interface: Built in touch screen.

8.5 Environmental Specification

Operating temperature: O C to 50 C

Storage temperature: O C to 55 ^{O}c

Relative Humidity: 10 to 90% non-condensing

8.6 Input Power Supply

Input Power Mains supply: 90 Volts to 265 volts, AC Single Phase, Frequency 50/60Hz

8.7 The Test equipment shall be offered complete with the items mentioned below

- Main equipment i.e. SFRA testing kit with followings Power supply cord,
  02 Active proves with 15 m double shielded cables,
  02 ground tape/leads 10 m,
  02 Ground tape/lead clamp,
  Storage case and bag for cables
  User/Maintenance Manual 02 set
  Calibration/Test certificates 02 set
  Main cable CDs with external PC analysis software

8.8 Spare Leads

- 01 set of spare cables (02 Active proves-Source & Receiver with 15 m double shielded cables) to be included in scope of supply Connection to circuit to be tested

8.9 Performance & Warranty Certificate:

- The Supplier shall guarantee the product performance for 24 months from the date of successfully commissioning at our works and shall provide spares and services during guarantee period to maintain the Sound Level meter in working condition.

8.10 Training and demonstration and acceptance

- Training and demonstration should be offered by supplier's representative free of charge.
- Demonstration of all features of TTR and all accessories to satisfaction of customer
- Original technical catalogue to be included with technical bid.

9. Technical specification of a Three-phase transformer turns ratio test equipment.

9.1 General description

- The 3-phase transformer turns ratio tester as envisaged test set can be used to test single phase and three phase transformers, both with and without taps.
- The test set should be fully automatic capable for finding out the Turns ratio & Voltage ratio of three phase & single-phase transformers.
- The test set should be able to give direct readings of the ratio of test object automatically i.e. Microprocessor/PC based without any bridge balancing method involved.
- The test set should be able to take the measurements automatically, for three phase transformer measurement of the three phases to be conducted simultaneously & automatically without any manual changes of phases. Phase changeover should be automatic through instruments internal circuit. Instrument should have provision for detecting & displaying the 'following electrical parameters:
- The test equipment shall have a numerical display which clearly and unambiguously states the values and viewable in bright sunlight and low light levels.
- The test equipment shall be able to automatically detect vector group of three phase transformer and auto transformers.
- The test equipment shall have a built-in tap-changer control unit, which allows remote on-load tap changer operation.
- The instrument should have detachable test leads for avoiding damage to the cables as well as to the instrument.
- The test set should have safety monitoring system to ensure perfect grounding of test system while test is under progress and the accessories required for the same are also to be supplied along with the instrument.
- The test kit shall meet all the relevant safety specifications as per applicable standards
- The portable Transformer Turns Ratio Test Set shall be capable of taking different measurements, including:

    a) Transformer,

    b) Reactor,

    c) current transformer (CT),

    d) voltage transformer (PT)

    e) Z-type connection

9.2 Features:

a) Portable, light weight, automatic, 3 phase Turns Ratio Meter

b) Automatic measurement of Ratio and phase angle deviation

c) Suitable for operation in energized HV yard condition.

d) Should be able to measure and display actual turn's ratio of Three phase transformer having different vector groups.

e) It should also measure and display, magnetizing current along with phase angle deviation.

9.3 Data display:

i. Turns Voltage ratio of all three phase.
ii. Phase angle deviation of all three phase
iii. Display & detection of vector group of transformers under test.
iv. '%Error of all three phase
v. Excitation current of all three phases

9.4 Display:

- Back lit graphic display/bright red LED easily readable with large character size viewable in direct sunlight and low light level. Display parameters, Ratio, excitation current, phase angle deviation.
- The test voltage to be applied on the object under test should be independent of the supply frequency to avoid any deviation in the frequency during the testing.
- The accuracy, reliability, steadiness and the repeatability of the readings should not be affected with the test voltages.

9.5 Input Power supply

- 230V+/- 10%,50HZ Single phase,2Amp
- Excitation voltage for test:40volts or higher with user selection.
- The test set should have necessary provision for storage of the lest results for retrieval and analysis in the associate laptop PC. The required software for Measurements and data storage should also be supplied along with the test set. The software should be user friendly and PC based
- Operator control: Keypad menu should bedriven for setup, data input and result storage internal record storage

9.6 Environmental Conditions

- Operational temperature 0-50°C
- Humidity:0-90% non-condensing
- Storage temperature 0-50°C
- Ambient Temperature 0-50°C

9.7 Protection

Instrument should be protected against the following:

- Transformer high excitation voltage due to shorted turns faults
- Incorrect connection„
- Transient voltage protection.
- Surge voltage protection etc.

9.8 The ranges resolution, accuracy of the test set for different parameters should be at least at the points mentioned below:

.Parameter	Requirement
Test range	0.8-10000

Minimum resolution	0.0001
Accuracy	±0.2%(turns ratio<1000), ±0.3%(turns ratio 1000~10000)
Output voltage	Max 35V/50Hz
Testing times	≥800 times (quick mode)
Storage data	100 sets
Temperature in operation	-10℃ to 40℃
Relative humidity	≤90%, No dew
Dimensions	53cm X 43cm X 24cm
Net weight	10 kg Max
Display Full Graphics	LCD module, adjustable back-lighting, wide temperature range, 128 x 64 dots (21 characters by 8 lines) viewable in bright sunlight and low-light levels
Excitation Current Range	0 to 100 mA, 4-digit resolution

9.9 The test equipment shall be offered complete with items mentioned below

Main equipment i.e.

- Transformer turns Ratio meter.
- Power supply cord.
- Storage case and bag for cables

Cable Set

- 15 meter single phase set with alligator clip termination
- 15 meter three phase set with alligator clip termination
- Safety ground lead 10meter (min) with clamp

Hardware and software

- Two sets of operating and maintenance manuals in English language.
- One additional set of all the above documentation in soft copy.
- Three sets of calibration reports covering range of the equipment with the following details should be provided.

Calibration

- Calibration date, periodicity, calibration validity duration and next calibration due date. Traceability details of standard used for calibration. All documents should be endorsed by authorised signature.

9.10 Performance and warranty/Guarantee Certificates

- The Supplier shall guarantee the product performance for 24 months from the date of delivery and shall provide spares and services during the guarantee period to maintain the three phase TTR in working condition.

9.11 Training and demonstration and acceptance

- Training and demonstration should be offered by supplier's representative free of charge.
- Demonstration of all features of TTR and all accessories to satisfaction of customer
- Original technical catalogue to be included with technical bid.

9.12 Spares

- All types of spares for Turns Ratio Meter and its accessories should be available for at least five years after, trouble free operating should be included after supply of the instruments. The vendor shall provide list of spares and drawing of parts/details of spares.
- Supplier should also provide other attachment [accessories required for smooth functioning of the instrument. Supplier should provide past performance certificate of similar equipment supplied within three years along with customer (i.e. Name of organization, contact number).

Note:

NB :Supplier should submit his technical compliance/comments against above points in above format.' Technical bid without complete technical compliance sheet will not be considered for technical evaluation.

10. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Mbali Mapaila	HV Plant Manager

11. Revisions

Date	Rev	Compiler	Remarks
21/10/2022	1	Marks Mathelele	New document
21/05/2023	2	Marks Mathelele	Added mandatory requirements

12. Development team

The following people were involved in the development of this revision and/or the original revision of this document:

- Dilahlwane Mashego

13. Acknowledgements

None