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|  | <b>Specification</b> | <b>NTCSA</b> |
|---|----------------------|--------------|

Title: **Technical Specification for Analogue and Digital radio test set**

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### **CONTROLLED DISCLOSURE**

## **1. Introduction**

Eskom operates UHF and VHF narrowband area radio networks. The UHF radio network is primarily used exclusively for SCADA communication, the UHF radio network consists of a mixture of legacy analogue repeaters and newer digital repeaters. The VHF radio network is used exclusively for mobile operational voice communication and operates in the 150Mhz and 400Mhz band. The VHF radio network was based on the legacy analogue radio repeater technology but is currently being migrated to the DMR Tier III repeaters. The operation and field technicians require a radio test set instruments that can test the legacy analogue repeaters as well the DMR repeaters to enable them to install, commission and maintain the UHF and VHF radio networks.

## **2. Supporting Clauses**

### **2.1 Scope**

#### **2.1.1 Purpose**

This document outlines the specification for requirements of the supply and delivery of the analogue and digital radio test set.

#### **2.1.2 Applicability**

This document shall apply throughout Telecommunications.

#### **2.1.3 Effective date**

This document shall be effective once all parties have signed the document.

### **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] 240-90220801: Telecommunication Last Mile Roadmap

#### **2.2.2 Informative**

None

### **2.3 Definitions**

None

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## 2.4 Abbreviations

| Abbreviation       | Explanation  |
|--------------------|--|
| AM                 | Amplitude Modulation   |
| ARIB T98           | Digital Convenience Radio Equipment for Simplified Service Standard                                  |
| DMM                | Digital Multimeter   |
| DMR                | Digital Mobile Radio   |
| dPMR               | digital private mobile radio   |
| FM                 | Frequency Modulation   |
| NXDN               | Next Generation Digital Narrowband,  |
| P25<br>P25 Phase 2 | Project 25 (P25 or APCO-25) is a suite of standards for interoperable digital two-way radio products |
| T/R                | Transmit/Receive   |
| Tetra              | Terrestrial Trunked Radio  |
| UHF                | Ultra-High Frequency   |
| VHF                | Very High Frequency  |

## 2.5 Roles and Responsibilities

**Suppliers:** to supply and deliver the analogue and digital radio test set as per the specification and provide basic training on the use of the radio test set for fault diagnostics and maintenance.

**Telecommunications Ops & Field:** To provide repeaters (Trio EB450 /QB450 and DMR TB9400 /TB9300) to enable supplier to demonstrate the use of radio test for fault diagnostics and maintenance.

## 2.6 Process for Monitoring

Implementation of the scope will be monitored throughout the contracting process.

## 2.7 Related/Supporting Documents

None

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### **3. Technical Specification for Analogue and Digital radio test set**

The analogue and digital radio test set must be capable of testing both legacy analogue systems as well as the new emerging digital standards such as the DMR (trunked) repeaters. At minimum the tester must support the requirements below.

#### **3.1 General Specification**

- RF Receiver Testing - Up to 1 GHz bandwidth; AM, FM, frequency, and level measurements
- RF Transmitter Testing - Up to 1 GHz bandwidth; AM, FM, 1 kHz / 150 Hz and external modulation sources.
- RF Generator: -5 dBm to -125 dBm with  $\pm 1.5$  dB (typical) accuracy
- Test Range: -140 dBm to 57dBm
- Direct input power: 50 W Continuous, 125 W Cyclical
- Colour LCD display screen
- Internal Battery backup
- Rugged: 30 G Shock (Functional shock)
- Tracking Generator for the measurement of VSWR, Return Loss, Distance to Fault and Tuning Duplexers
- Analogue and digital radio test set to be supplied with soft carry case.
- Analogue and digital radio test to be supplied with factory calibration certificate and at minimum 1 year warranty (Supplier to also indicate calibration frequency)

#### **3.2 Technologies to be supported by the radio test set**

At minimum the following technologies needs to be supported by the analogue and digital radio test set equipment

- P25
- P25 Phase 2
- NXDN
- Tetra
- dPMR
- AM
- FM
- DMR Repeater (Tier 3)
- ARIB T98
- Positive Train Control

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### 3.3 Analogue test features to be supported by the radio test set.

| Analogue test features to be supported   |
|--|
| 1Ghz RF Generator (AM/FM)  |
| 1Ghz Receiver (AM/FM)  |
| Oscilloscope   |
| Channel Analyzer   |
| Dual Modulation Source   |
| Audio Frequency counter  |
| DTMF Encode/Decode   |
| <b>Meters</b> <ul style="list-style-type: none"><li>- Digital Multimeter</li><li>- Audio Level Meter</li><li>- Distortion Meter</li><li>- SINAD Meter</li><li>- RF Power Meter</li><li>- RF Frequency Error Meter</li><li>- In-band Power Meter RSSI</li></ul> |

### 3.4 Digital test features to be supported by the radio test set

| Digital Test Features supported   |
|---|
| Digital Test Patterns   |
| Distribution, Constellation, Eye Diagram Plots  |
| TDMW Burst Profile and Mask for DMR and P25 Phase 2   |
| <b>Meters</b> <ul style="list-style-type: none"><li>- Signal Power</li><li>- Slot Power</li><li>- FSK error</li><li>- Symbol Deviation</li><li>- Magnitude</li><li>- Symbol Clock error</li></ul> |

### 3.5 DMR Testing capabilities.

- Analogue and digital radio test set must be capable of testing DMR Tier III repeaters. Current installed base is the DMR TB9400 and TB9300 repeaters.
- The Radio test set must be capable of testing the transmitter and receiver of the DMR repeater.

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### 3.6 Input /Output connections

| I/O Connections                               |
|---|
| T/R Connector Type: N-Type Female             |
| ANT Connector Type: N-Type Female             |
| GEN Connector Type: N-Type Female             |
| Scope Connector Type: BNC Female              |
| AUD IN Connector Type: BNC Female             |
| AUD OUT Connector Type: BNC Female            |
| Headphone Jack: 3.5 mm Jack                   |
| USB Connectors Type: USB Type A               |
| External 10 MHz Reference Input: BNC Female   |
| Ethernet Connector Type: RJ45                 |
| DC Power in Connector: 2-position 2.5 mm Jack |
| GND Connector: Banana                         |
| DMM (Qty 3): Banana (Optional)                |
| IN (In-Line Power Meter): N-Type Female       |
| OUT (In-Line Power Meter): N-Type Female      |

### 3.7 Training Requirements

Supplier to provide training on use of the analogue and digital radio test set to demonstrate usage of the RF radio test for fault finding and maintenance. Training to include video material on how to use test set on Trio EB450 /QB450 and DMR TB9400 /TB9300.

### 3.8 Technical Evaluation Criteria

**The following documents shall form part of the tender returnable that suppliers will be evaluated on:**

1. Annex A: Schedule of Compliance must be completed and submitted. (See Appendix A)
2. Written confirmation from the Original Equipment Manufacturer (OEM) that the Supplier is an approved Agent/Distributor
3. Written confirmation of in-country availability of maintenance support and calibration of equipment of equipment for 5 years post purchase
4. Submission of Radio Test set Datasheets

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#### **4. Acceptance**

This document has been seen and accepted by:

This document has been seen and accepted by:

| <b>Name</b>             | <b>Designation</b>        |
|-------------------------|---------------------------|
| Mark Ganesan            | Central Region Manager    |
| Dennis Wesinyane        | Snr Supervisor- Welkom    |
| Robert Janse Van Vuuren | Snr Technician - Welkom   |
| Nomposiso Klaas         | Snr Supervisor - Upington |

#### **5. Revisions**

| <b>Date</b> | <b>Rev.</b> | <b>Compiler</b> | <b>Remarks</b>                             |
|-------------|-------------|-----------------|--|
| July 2024   | 1           | Sandy Nxumalo   | New specification for Radio test equipment |

#### **6. Development Team**

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

- Sandy Nxumalo

#### **7. Acknowledgements**

None

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## Appendix A – – Evaluation Criteria

### Mandatory Criteria (Technical Gate Keepers)

| Item             | Mandatory Criteria  | Allocation (%) |
|------------------|---|----------------|
| 1                | Annex A: Schedule of Compliance must be completed and submitted.  | 5.00%          |
| 2                | Written confirmation from the Original Equipment Manufacturer (OEM) that the Supplier is an approved Agent/Distributor                          | 5.00%          |
| 3                | Written confirmation of in-country availability of maintenance support and calibration of equipment of radio test set for 5 years post purchase | 5.00%          |
| 4                | Submission of Radio Test set Datasheets   | 5.00%          |
| <b>Threshold</b> |   | <b>20%</b>     |

Suppliers who do not meet the mandatory criteria submission will not be evaluated any further

| Item | Consolidated  | Total       |
|------|---|-------------|
| 1    | Mandatory Criteria  | 20%         |
| 2    | Analogue and Digital Radio test set tester (Annex A – Schedule of Compliance) | 80%         |
|      | <b>Total Score</b>  | <b>100%</b> |
|      | <b>Minimum Threshold (Pass)</b>   | <b>80%</b>  |

Only suppliers that meet the minimum threshold of (80%) will be considered for further evaluations.

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| <b>Annex A – Schedule of Compliance</b> |  |   |                                     |
|---|--|---|-------------------------------------|
|   | <b>Description: Analogue and Digital Radio test set</b>  | <b>Schedule A (NTCSA requirement statement)</b> | <b>COMPLIANT/<br/>NON-COMPLIANT</b> |
|   | <b>Specification</b>   |   |                                     |
| <b>3.1</b>                              | <b>General Specification</b>   |   |                                     |
| 3.1.1                                   | RF Receiver Testing - Up to 1 GHz bandwidth; AM, FM, frequency, and level measurements   | State Compliance & Provide Evidence             |                                     |
| 3.1.2                                   | RF Transmitter Testing - Up to 1 GHz bandwidth; AM, FM, 1 kHz / 150 Hz and external modulation sources   | State Compliance & Provide Evidence             |                                     |
| 3.1.3                                   | RF Generator: -5 dBm to -125 dBm with ±1.5 dB (typical) accuracy   | State Compliance & Provide Evidence             |                                     |
| 3.1.4                                   | Test Range: -140 dBm to 57dBm,   | State Compliance & Provide Evidence             |                                     |
| 3.1.5                                   | Direct input power: 50 W Continuous, 125 W Cyclical  | State Compliance & Provide Evidence             |                                     |
| 3.1.6                                   | Colour LCD display screen  | State Compliance & Provide Evidence             |                                     |
| 3.1.7                                   | Internal Battery backup  | State Compliance & Provide Evidence             |                                     |
| 3.1.8                                   | Rugged: 30 G Shock (Functional Shock)  | State Compliance & Provide Evidence             |                                     |
| 3.1.9                                   | Tracking Generator for the measurement of VSWR, Return Loss, Distance to Fault and Tuning Duplexers  | State Compliance & Provide Evidence             |                                     |
| 3.1.10                                  | Analogue and digital radio test set to be supplied with soft carry case.   | State Compliance & Provide Evidence             |                                     |
| 3.1.11                                  | Analogue and digital radio test to be supplied with factory calibration certificate and 1 year warranty (Supplier to indicate calibration frequency) | State Compliance & Provide Evidence             |                                     |
| <b>3.2</b>                              | <b>Technologies to be supported by the radio test set</b>  |   |                                     |
| 3.2.1                                   | P25  | State Compliance & Provide Evidence             |                                     |

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|            |                                      |                                     |  |
|------------|--------------------------------------|-------------------------------------|--|
| 3.2.2      | P25 Phase 2                          | State Compliance & Provide Evidence |  |
| 3.2.3      | NXDN                                 | State Compliance & Provide Evidence |  |
| 3.2.4      | Tetra                                | State Compliance & Provide Evidence |  |
| 3.2.5      | dPMR                                 | State Compliance & Provide Evidence |  |
| 3.2.6      | AM                                   | State Compliance & Provide Evidence |  |
| 3.2.7      | FM                                   | State Compliance & Provide Evidence |  |
| 3.2.8      | DMR Repeater ( Tier 3)               | State Compliance & Provide Evidence |  |
| 3.2.9      | ARIB T98                             | State Compliance & Provide Evidence |  |
| 3.2.10     | Positive Train Control               | State Compliance & Provide Evidence |  |
| <b>3.3</b> | <b>Analogue Test Features</b>        |                                     |  |
| 3.3.1      | 1Ghz RF Generator (AM/FM)            | State Compliance & Provide Evidence |  |
| 3.3.2      | 1Ghz Receiver (AM/FM)                | State Compliance & Provide Evidence |  |
| 3.3.3      | Oscilloscope                         | State Compliance & Provide Evidence |  |
| 3.3.4      | Channel Analyzer                     | State Compliance & Provide Evidence |  |
| 3.3.5      | Dual Modulation Source               | State Compliance & Provide Evidence |  |
| 3.3.6      | Audio Frequency counter              | State Compliance & Provide Evidence |  |
| 3.3.7      | DTMF Encode / Decode                 | State Compliance & Provide Evidence |  |
| 3.3.8      | Tone Remote/Two-tone-Tone Sequential | State Compliance & Provide Evidence |  |

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|       |  |                                     |  |
|-------|--|-------------------------------------|--|
| 3.3.9 | Meters<br>- Digital Multimeter<br>- Audio Level Meter<br>- Distortion Meter<br>- SINAD Meter<br>- RF Power Meter<br>- RF Frequency Error Meter<br>- In-band Power Meter RSSI | State Compliance & Provide Evidence |  |
| 3.4   | <b>Digital Test Features</b>   |                                     |  |
| 3.4.1 | Digital Test Patterns  | State Compliance & Provide Evidence |  |
| 3.4.2 | Distribution, Constellation, Eye Diagram Plots   | State Compliance & Provide Evidence |  |
| 3.4.3 | TDMW Burst Profile and Mask for DMR and P25 Phase 2  | State Compliance & Provide Evidence |  |
| 3.4.4 | Meters<br>- Signal Power<br>- Slot Power<br>- FSK error<br>- Symbol Deviation<br>- Magnitude<br>- Symbol Clock error   | State Compliance & Provide Evidence |  |
| 3.5   | <b>DMR repeater testing capabilities.</b>  |                                     |  |
| 3.5.1 | Capabilities of testing DMR Tier III repeaters.  | State Compliance & Provide Evidence |  |
| 3.5.2 | Testing the transmitter and receiver of the DMR repeater.  | State Compliance & Provide Evidence |  |
| 3.6   | <b>Input/Output connections</b>  |                                     |  |
| 3.6.1 | T/R Connector Type: N-Type Female  | State Compliance & Provide Evidence |  |
| 3.6.2 | ANT Connector Type: N-Type Female  | State Compliance & Provide Evidence |  |
| 3.6.3 | GEN Connector Type: N-Type Female  |                                     |  |
| 3.6.4 | Scope Connector Type: BNC Female   | State Compliance & Provide Evidence |  |

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|        |   |                                     |  |
|--------|---|-------------------------------------|--|
| 3.6.5  | AUD IN Connector Type: BNC Female   | State Compliance & Provide Evidence |  |
| 3.6.6  | AUD OUT Connector Type: BNC Female  | State Compliance & Provide Evidence |  |
| 3.6.7  | Headphone Jack: 3.5 mm Jack   | State Compliance & Provide Evidence |  |
| 3.6.8  | USB Connectors Type: USB Type A   | State Compliance & Provide Evidence |  |
| 3.6.9  | External 10 MHz Reference Input: BNC Female   | State Compliance & Provide Evidence |  |
| 3.6.10 | Ethernet Connector Type: RJ45   | State Compliance & Provide Evidence |  |
| 3.6.11 | DC Power in Connector: 2-position 2.5 mm Jack   | State Compliance & Provide Evidence |  |
| 3.6.12 | GND Connector: Banana   | State Compliance & Provide Evidence |  |
| 3.6.13 | DMM (Qty 3): Banana   | State Compliance & Provide Evidence |  |
| 3.6.14 | IN (In-Line Power Meter): N-Type Female   | State Compliance & Provide Evidence |  |
| 3.6.15 | OUT (In-Line Power Meter): N-Type Female  | State Compliance & Provide Evidence |  |
| 3.7    | <b>Training Requirements</b>  |                                     |  |
| 3.7.1  | Training Material /Videos on radio test set configuration for fault diagnostics.                | State Compliance & Provide Evidence |  |
| 3.7.2  | Training on Basic configuration of radio test set for Trio(EB450/QB450) and DMR (TB9400) radios | State Compliance & Provide Evidence |  |

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