



SPECIFICATION FOR RADIO REPEATER

SPC-00851

August 2022

Revision 5

SPC-00851

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I. DISTRIBUTION

Once updated, a copy of the latest revision will be published in the document management system in use. E-mail to this effect will be sent to the relevant personnel or heads of department.

II. DOCUMENT CHANGE HISTORY

ISSUE NO.	DATE ISSUED	ISSUED BY	HISTORY DESCRIPTION
1.00		Graeme Daly	New document
2.00	18 July 2011	M Mmbengwa	Amended document
3.00	31 August 2022	A. Nkomane	Amended document

III. CHANGES SINCE LAST REVISION

CLAUSES	DESCRIPTION
5.1.4	Change the reference from sub-clause 5.1.2 to 5.1.3
5.1.3	Change cabinet to casing/housing
5.2.2	Power will be indicated on the schedule of requirements.
Clause 5.5	Include combiner
10.1	Include hysteresis clause on load shed
6.1, 6.2, 6.3	Removed

IV. ABBREVIATIONS, ACRONYMS AND DEFINITIONS

ABBREVIATIONS AND ACRONYMS	DESCRIPTION
CD	Compact Disk
CTCSS	Continuous Tone Coded Squelch System
dB	decibel
dB(C)	decibel relative to the carrier power
DC	Direct Current
Hz	Hertz
kHz	Kilohertz
ICASA	Independent Communication Authority of South Africa
ISO	International Standards Organisation
LBU	Line Branching Unit
LED	Light Emitting Diode
MHz	Megahertz
ms	Millisecond
PC	Personal Computer
RF	Radio Frequency
RSSI	Receive signal strength indication
Rx	Radio receiver
SANS	South African National Standard
SINAD	Signal, noise & distortion to noise and distortion ratio
Tx	Radio Transmitter
UHF	Ultra High Frequency
VSWR	Voltage Standing Wave Ratio

DEFINITIONS	DESCRIPTION
Flat response	No variation from the reference value.
Angle Modulation	A term used to encompass both frequency modulation and phase modulation.

SPC-00851**V. RELEVANT DOCUMENTATION**

The following standards are referred to in this specification:

APPLICABLE

DOCUMENT NO.	DESCRIPTION	LOCATION
ISO 9000	Quality management systems.	
BS 3939	Graphics symbols for electrical, power, telecommunications and electronic diagrams.	External
SANS 10313	Protection of dwelling houses against lightning.	External
SANS 61643-1	Surge arrestors for low voltage distribution systems.	External
BBD8635	Technical Specification and Methods of Measurement for Angle Modulated Radio Equipment	TFR, Infrastructure Telecoms.

The latest issues of the abovementioned standards must apply.

RELEVANT

DOCUMENT NO.	DESCRIPTION	LOCATION
SPC-00851	Old specification No. SCEH-59	Document Control Centre

SPC-00851**1. SCOPE**

This specification covers the requirements of Transnet for the supply of a radio repeater station, operating in the UHF frequency band with 12.5 kHz channel spacing.

2. COMPLIANCE

- 2.1 Offers which include deviations of a minor nature, not departing greatly from the specification, will be considered at the discretion of Transnet
- 2.2 Tenderers may offer alternatives for consideration. Alternative offers are to be reflected on a separate schedule and the following particulars are to be provided
 - 2.2.1 A fully detailed technical description in English explaining functioning of the individual components, the operation of the items of equipment as well as the procedure to be followed in clearing faults and maintenance.
 - 2.2.2 Drawings and brochures supporting the offer.
 - 2.2.3 Details of deviations from the specifications of Transnet
 - 2.2.4 The value of imported and local components of complete items is to be stated separately.

SPC-00851**3. SERVICE CONDITIONS**

3.1 The equipment must be suitable for continuous operation under the following conditions:

Altitude:	0 to 1 800 metres above sea level
Ambient temperatures:	- 10 °C to + 60 °C
Air pollution:	Heavily saline laden industrial and locomotive fumes
Relative humidity:	As high as 95 %
Lightning:	Severe

3.2 All component parts, including wiring, etc. must be manufactured and processed to ensure reliable operation under these conditions.

4. SCHEDULE OF REQUIREMENTS

4.1 Where only equipment in terms of this specification is required by Transnet, a Schedule of Requirements will accompany this specification. Where a system, including other equipment, is to be supplied, a main specification will be included in the tender documents together with a Schedule of Requirements for all the equipment.

4.2 The equipment required is listed in the Schedule of Requirements. The equipment must comply with the details therein, in addition to the requirements of the relevant clauses of this specification.

SPC-00851**5. REPEATER****5.1 General**

- 5.1.1 The equipment provided must be ICASA type approved.
- 5.1.2 The repeater equipment must comprise of a transmitter, receiver, associated electronic equipment, duplexer and power supply mounted in a corrosion resistant metal casing/housing, which must be suitable for indoor installation.
- 5.1.3 The equipment described in sub-clause 5.1.3 must be available as standard production items. Tenderers for equipment which cannot meet this requirement will not be considered.
- 5.1.4 Provision must be made for the inclusion, in the case of a conventional repeater: of a Line Branching Unit between the transmitter and receiver. Controlling by E & M signalling. The audio lines shall be balanced 600 and the nominal audio signal level -10 dBm at 60 % modulation. The return loss shall be 25 dB. Detailed specification for the LBU will be provided when the unit is required.
- 5.1.5 The repeater must be suitable to be installed into a 19" rack.
- 5.1.6 Provision must be made for the inclusion, in the case of trunked repeater: compatibility to Fylde MPT1327 network.
- 5.1.7 Supplier must provide interface cable connection diagrams for connection from repeater to Fylde Trunking equipment.
- 5.1.8 The repeater provided must be provided with a migration plan from analogue to digital.
- 5.1.9 It must be possible to control the repeater station by all of the following methods.

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- 5.1.9.1 Extended local control, where the repeater is connected to a control console by means of a multi-core cable up to 100 metres in length.
- 5.1.9.2 Remote control, where the equipment is connected to a control console by means of a single telephone cable pair up to 10 kilometres in length.
- 5.1.9.3 Line controlled over telephone carrier channels on a 6-wire basis with E and M signalling. This method will require the use of a line branching unit or a line terminating unit.
- 5.1.9.4 Remote monitoring, configuration and diagnostics via dial-up modem and Ethernet connections.
- 5.1.10 The RF power, line levels and frequency should be software controlled; there should be no need to open up the equipment to change settings.
- 5.1.11 All indicators and connection points must be clearly labelled.
- 5.1.12 The equipment used to configure the repeater unit should be specified (e.g. PC using Windows platform or proprietary hand held device).
- 5.1.13 The equipment must be designed and rated for continuous transmission duty cycle at maximum rated power.
- 5.1.14 An engineering panel must be provided for local control and testing of the repeater and line interface equipment. Facilities to key the transmitter and monitor the received audio must be included. A monitor loudspeaker with volume control must be provided. A handset with a dynamic microphone must be provided as part of the engineering panel for speech transmission from the repeater. The engineering panel must have no affect (level, distortion, frequency response) on the 600 Ω balanced audio lines.
- 5.1.15 Pre-emphasis of 6 dB per octave must be used in the transmitter with de-emphasis in the receiver. Provision must be made to switch to flat frequency response.

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- 5.1.16 The repeater must be angle modulated and be suitable for operating in frequency bands using 12.5 kHz channel spacing.
- 5.1.17 The equipment must be supplied complete for operation in the frequency band specified in the Schedule of Requirements.
- 5.1.18 The successful tenderer will be advised of the actual frequencies once the order has been placed.
- 5.1.19 The repeater must be suitable for transmitting and receiving on a single antenna. The antenna duplexer must be included in the equipment cabinet.
- 5.1.20 The operating voltage and negative or positive earth of the equipment shall be as indicated in the Schedule of Requirements.
- 5.1.21 The equipment must be able to operate in the following DC voltage ranges without degrading the performance.
- | | |
|----------------------|---|
| For a 12 volt system | Nominal operating voltage 13,8 volt
Operating range 10,8 volt to 15,6 volt |
| For a 24 volt system | Nominal operating voltage 27,6 volt
Operating range 21,6 volt to 31,2 volt |
| For a 48 volt system | Nominal operating voltage 55,2 volt
Operating range 43,2 volt to 62,4 volt |
- 5.1.22 The terminals for the connection of the DC voltage must be clearly marked and the equipment protected against incorrect polarity, short-circuiting, and over voltage. Full particulars of all protective devices offered must be submitted.
- 5.1.23 All RF terminals must be N-Type connectors.
- 5.1.24 Tenderers must guarantee that there will be no cross-coupling or any other degradation in radio equipment performance due to a common battery and charger combination being used to supply the repeater.

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- 5.1.25 The equipment must be of fully solid-state design.
- 5.1.26 Tenderers are to submit their recommendations for earthing of the equipment.
- 5.1.27 All the miscellaneous items such as plugs, connectors and cables, necessary for a complete installation, must be supplied with the equipment.
- 5.1.28 The RF switching bandwidth of the equipment offered must be 1.7 MHz without degradation in transmitter or receiver performance. The tenderer must state the degradation in receiver sensitivity, transmitter power and any other parameter for the switching bandwidth 2.0 MHz.
- 5.1.29 The repeater must be able to reverse the operating channels (e.g., Tx low, Rx high and Tx high, Rx low) without degradation in performance.
- 5.1.30 The transmitter circuitry must incorporate protective devices to protect the output circuitry when the transmitter is operated with the antenna open circuit or short-circuit, or for any excessive voltage standing wave ratio (VSWR) on the antenna feeder cable.
- 5.1.31 The repeater must be provided with standard multipin sockets and plugs for the easy interconnection of control consoles, carrier circuits, batteries and any other devices stated in the schedule of requirements.
- 5.1.32 Tenderers must state the DC current consumption at the nominal operating voltage of all equipment offered under transmit, receive and stand-by conditions.
- 5.1.33 The equipment will be used where severe lightning and voltage surges occur. The repeater must therefore be provided with adequate line protection devices. Voltage transient surge protection must be provided in the AC mains supply input.

SPC-00851**5.2 Transmitter**

- 5.2.1 For the parameters required for the transmitter refer to BBD8635 specification.
- 5.2.2 The output power of the transmitter will be indicated in the schedule of requirements.
- 5.2.3 The transmitter must be able to transmit CTCSS signals.
- 5.2.4 When provision must be made for an audio input (e.g. from a land line) to the transmitter, the audio frequency response must be within -1 to +3 dB of a true 6 dB per octave pre-emphasis characteristic between 300 and 3 000 Hz (reference level 0 dB at 1 000 Hz) at a modulation factor of 20% of maximum rated system deviation.
- 5.2.5 The transmitter shall operate into a 50 Ω impedance antenna system.
- 5.2.6 In the event of a high VSWR the transmitter should reduce power to prevent damage to equipment.

5.3 Receiver

- 5.3.1 For the parameters required for the receiver refer to BBD8635 specification.
- 5.3.2 Receiver must be able to receive CTCSS signals.
- 5.3.3 The receiver must be provided with an electronic squelch control the sensitivity of which must be adjustable. The squelch control specification must adhere to BBD8635.
- 5.3.4 The audio power output into the built-in monitor loudspeaker must be at least 500 milliwatts at less than 5% harmonic distortion.

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- 5.3.5 When provision must be made for an audio output (e.g. to a land line) from the receiver, the audio frequency response must be within + 1 dB to -3 dB of a true 6 dB per octave de-emphasis characteristic from 300 Hz to 3 000 Hz at a modulation factor of 20% of maximum rated system deviation. It will be stated in the Schedule of Requirements if an audio output is required.
- 5.3.6 The frequency stability must be at least ± 0.0002 % over the temperature range of -10 °C to + 60 °C (reference temperature +25 °C).
- 5.3.7 Tenderers must state what protection will be provided, and what maximum RF signals the receiver will be protected against without damage.
- 5.3.8 The impedance of the antenna terminal shall be 50 Ω .
- 5.3.9 The blocking shall be ≥ 84 dB.
- 5.3.10 A RSSI output terminal must be provided.

5.4 Through Signals

- 5.4.1 Refer to Specification BBD8635.

5.5 Antenna Duplexer/Combiner

- 5.5.1 The repeater equipment must be supplied complete with antenna duplexer/combiner to obviate the use of two antennas.
- 5.5.2 For detailed specification on antenna duplexer/combiner see Specification BBD8635.
- 5.5.3 The antenna duplexer/combiner must be capable of handling the transmitter RF output power.
- 5.5.4 The Tenderer must state the change in characteristics over the temperature range of -10 °C to + 60 °C.

SPC-00851**6. QUALITY OF MATERIAL**

- 6.1 Materials which may, under the influence of heat, light or pressure, decompose or liberate elements or compounds likely to corrode or affect other materials or cause electrolytic corrosion will not be acceptable.
- 6.2 Mounting screws, where used, must not be self-tapping. Bushes and threaded inserts must be used.
- 6.3 All covers, jacks, sockets etc. must be provided with adequate seals.
- 6.4 The functions of all controls, switches, etc. must be clearly engraved or otherwise permanently marked by means of approved symbols or English wording.
- 6.5 All components must be suitably rated for the function they have to perform without interference to neighbouring material.
- 6.6 Resistors and restive components must not rise in temperature so that mounting boards or markings thereon are burnt or discoloured.
- 6.7 Fuses must be rated to give adequate protection to the circuit served while not rupturing prematurely.
- 6.8 The equipment layout must be constructed to facilitate fault clearance and maintenance.

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6.9 All components must be clearly marked and must be capable of easy reference to circuit diagrams and handbooks that are supplied with the equipment.

7. ACCEPTANCE TESTS

7.1 Transnet will conduct acceptance tests on the equipment. The equipment will not be accepted nor will the payment be authorised until these tests have been completed and it has been confirmed that the equipment supplied is fully in accordance with the requirements of this specification and/or the stated claims of the tenderer as accepted by Transnet.

The following equipment must be submitted for acceptance tests.

7.1.1 Radio repeater sample.

7.1.2 Technical specification of repeater to be tested.

7.1.3 Technical service manual.

7.1.4 Software to program the repeater and to set technical parameters, with passwords if needed (technician level). Software that requires an internet connection is not acceptable.

7.1.5 Programming cables should be included.

7.1.6 Test box, cables and adapters for RF and electrical measurements.

7.2 All parameters shall be measured as specified in the controlled document BBD8635 Technical Specification and Methods of Measurement for Angle Modulated Radio Equipment.

7.3 The successful tenderer must agree to rectify any defects at no cost to Transnet, where the equipment does not meet the tender requirements and/or the stated claims made by the tenderer.

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7.4 All samples submitted for the quality assurance process will remain in the possession of Transnet for references:

7.4.1 Successful tenderer, twelve months after the equipment has been delivered.

8. MAINTENANCE AND SERVICE

8.1 The tenderer must give full particulars of the maintenance, spare parts and service facilities which will be available in the Republic of South Africa. The names and addresses of the companies concerned must be furnished.

8.2 The tenderer must list the major centres where maintenance facilities can be provided and must state if repairs under guarantee can be undertaken at these centres.

8.3 Tenderers must state what provision will be made to ensure an adequate supply of locally available spare components for a period of 10 years after the order is placed.

8.4 Transnet will not consider tenders from Tenderers who cannot provide an efficient spares and maintenance service. Tenderers must state whether they are prepared to agree to an inspection of their maintenance premises by the engineering personnel of Transnet.

9. TECHNICAL HANDBOOKS

9.1 Technical handbooks must be clearly and professionally printed in English on quality paper. Photostat copies will not be acceptable unless it simulates professional printing quality and in colour where applicable.

9.2 Technical information (handbooks) on CD is acceptable.

9.3 The technical handbooks must be packed with the equipment.

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9.4 Each set of handbooks must include the following:

- 9.4.1 Operating instructions.
- 9.4.2 Complete maintenance instructions.
- 9.4.3 Complete and detailed alignment procedures in a proven and easy to follow order.
- 9.4.4 A detailed technical description of the equipment.
- 9.4.5 Complete circuit diagrams, drawings and photographs of the equipment. The photographs and drawings must clearly indicate component and module location in the equipment. All component numbers must be clearly indicated.
- 9.4.6 A list of parts, giving the values of all components, i.e. resistive, capacitive, inductive, integrated circuit and semi-conductor numbers for each schematic, drawing.
- 9.4.7 Detailed printed circuit board wiring diagrams showing component numbers and positions and the wiring itself. Multilayer board wiring must be shown to include all layers of printed wiring clearly and discernible.
- 9.4.8 Voltage levels, current values and test points, must be clearly indicated on circuit diagrams and printed circuit board layouts.
- 9.4.9 Complete circuit diagrams of all individual modules.

9.5 All symbols and notations used on drawings and circuit diagrams preferably comply with the requirements laid down in BS 3939. Where symbols and notations do not comply with these requirements, each drawing shall be accompanied by a legend clearly detailing BS 3939 equivalents.

9.6 No hand-written notes and numbers must appear in a handbook supplied by a tenderer. All writing must be of proper printed form.

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9.7 Transnet reserves the right to reproduce in whole or in part, by any means whatsoever, any technical handbook or instruction manual supplied by the successful Contractor. Any such reproductions will be for the sole use of Transnet.

10. POWER SUPPLY

10.1 Should the equipment be supplied with a mains power supply/charger; the battery charging circuit must be provided with load shed. The load shed circuitry must have hysteresis to prevent unnecessary switching, as the battery normalises after the shedding of the load.

10.2 The equipment must be able to operate with a supply of 12V, 24V or 48V. The supply required will be indicated in the Schedule of Requirements.

10.3 In case of trunking application the equipment must have a power distribution unit (PDU) for use with Fylde equipment.

10.4 The power supply should have a separate Power management unit with the following requirements:

10.4.1 The Power management unit (PMU) must be a removable module.

10.4.2 The module must have indicators for the following conditions:

10.4.2.1 When it's working properly.

10.4.2.2 When there is a fault condition.

10.4.2.3 Provide an alarm when is fault condition exist.

11. ALARMS

11.1 The repeater should have an LED indicating alarm condition. The alarms should be software enabled and user configurable. The alarm conditions included are :

11.1.1 Temperature alarm.

11.1.2 Alarm log/history.

11.1.3 Alarm reporting.

SPC-00851**11.2 Transmitter Alarms**

- 11.2.1 Tx Low Power alarm
- 11.2.2 Tx High Power alarm
- 11.2.3 VSWR high alarm

11.3 Power Supply alarm

- 11.3.1 Mains failure
- 11.3.2 Load shed
- 11.3.3 Battery Low Non-urgent Alarms depending on supply voltage used are as follows
 - 11.3.3.1 For 12V volt system
 - 11.3.3.1.1 Low Non-urgent alarm is 12 volt
 - 11.3.3.1.2 Low urgent alarm is 11 volt
 - 11.3.3.2 For 24 volt system.
 - 11.3.3.2.1 Low Non-urgent alarm is 24 volt.
 - 11.3.3.2.2 Low urgent alarm is 22 volt
 - 11.3.3.3 For 48 volt system.
 - 11.3.3.3.1 Low Non-urgent alarm is 48 volt.
 - 11.3.3.3.2 Low urgent alarm is 43 volt

12. LINE INTERFACE

The line interface should be totally isolating all external equipment, both signalling and audio.

13. GENERAL

The tenderer must submit technical specification pamphlets and schematic diagrams covering the equipment offered. Photographs and complete drawings clearly displaying the external dimensions and physical appearance of the equipment must also be submitted with the tender.

When the tenderer provides software to work with the repeater, it must be specified what licences will be provided.

END OF DOCUMENT