



SPECIFICATION FOR RADIO REPEATER STATIONS

Uncontrolled Document

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Revision 3.00

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DOCUMENT AUTHORISATION

FUNCTION	NAME	TITLE & DIVISION	SIGNATURE	DATE
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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	October 1994	Transmission Engineering	New document
2.00	August 2006	Transmission Engineering	Converted to ISO 900 Standard
3.00	November 2006	Transmission Engineering	Amendments

III CHANGES SINCE LAST REVISION

CLAUSES	DESCRIPTION
All clauses	Converted to ISO standard
	Additions/changes and upgrades to the existing specifications to allow the unit to be more universal

IV ABBREVIATIONS, ACRONYMS AND DEFINITIONS

ABBREVIATIONS AND ACRONYMS	DESCRIPTION
FM	Frequency Modulation
CD	Compact Disk
Hz	Hertz
ISO	International Standards Organization
LED	Light Emitting Diode
DC	Direct Current
dB(W)	decibel relative to Watts
AC	Alternating current
dB	decibel
dB(C)	decibel relative to the carrier
kHz	Kilohertz
MHz	Megahertz
Pd	Power density
RF	Radio Frequency
SANS	South African National Standard
SWVR	Standing Wave Ratio
Tx	Transmit
UHF	Ultra High Frequency

V RELEVANT DOCUMENTATION

DOCUMENT NO.	DESCRIPTION	LOCATION
ISO 9000	Quality Management Systems	External
BS 3939 Graphic symbol for Electrical Power	Telecommunications and Electronic Diagrams	External
SPC-00846	Two-Way Mobile Radio communication Equipment (Old number SCEH-54)	Document Control Centre
SANS 10313	Protection of dwelling houses against lightning. External	External
SANS 61643-1	Surge arrestors for low voltage distribution systems.	External
SPC-00851	Old specification No. SCEH-59 Document	Control Centre

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1. SCOPE

This specification covers the requirements of Transnet Freight Rail for the supply of a radio repeater station, operating in the UHF frequency band with 12, 5 kHz channel spacing.

2. COMPLIANCE

2.1 Tenderers shall submit their main offers in terms of this specification. Deviations which are of a minor nature, and do not depart materially from this specification will be considered at the discretion of Transnet Freight Rail

2.2 Offers, which include deviations of a minor nature, not departing greatly from the specification, will be considered at the discretion of Transnet Freight Rail

2.3 Tenderers may offer alternatives for consideration. Alternative offers are to be reflected on a separate schedule and the following particulars are to be provided:

2.4 A fully detailed technical description in English explaining the 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.

2.5 Drawings and brochures supporting the offer.

2.6 Details of deviations from the specifications of Transnet.

2.7 The value of imported and local components of complete items is to be stated separately.

3. SERVICE CONDITIONS

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

Ambient temperature : -10° to 60° Celsius.

Relative humidity : As high as 95 %.

Altitude : 0 to 2 000 metres.

Air pollution : Heavily saline laden industrial and locomotive fumes containing metallic dust.

Relative humidity : As high as 95%.

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

3.3 The equipment must be suitable for operation under the stated conditions without the use of blower fans, heaters or air-conditioners etc.

4. SCHEDULE OF REQUIREMENTS

- 4.1 Where only equipment in terms of this specification is required by Transnet Freight Rail, 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.
- 4.3 The tenderers statement of compliance as per clause 2 must also cover the relevant clause of the Schedule of Requirements

5. REPEATER

5.1 General

- 5.1.1 The repeater equipment must comprise of a transmitter, receiver, associated electronic equipment, duplexer and power supply mounted in a corrosion resistant metal cabinet, which must be suitable for indoor installation.
- 5.1.2 It must be possible to control the repeater station by all of the following methods
- 5.1.2.1 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.
 - 5.1.2.2 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.
 - 5.1.2.3 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.

- 5.1.3 The interface equipment described in subclause 5.1.2 must be available as standard production items. Tenderers for equipment which cannot meet this requirement will not be considered
- 5.1.4 The equipment must be designed and rated for continuous transmission duty.
- 5.1.5 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-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.
- 5.1.6 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.
- 5.1.7 The equipment must be suitable for operating in frequency bands using 12, 5 kHz channel spacing.
- 5.1.8 The equipment must be supplied complete for operation in the frequency band specified in the Schedule of Requirements.
- 5.1.9 The successful tenderer will be advised of the actual frequencies once the order has been placed
- 5.1.10 The repeater must be suitable for transmitting and receiving on a single antenna. The antenna duplexer must be included in the equipment cabinet.
- 5.1.11 The operating voltage and negative or positive earth of the equipment shall be as indicated in the Schedule of Requirements
- 5.1.12 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

- 5.1.13 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
- 5.1.14 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
- 5.1.15 The equipment must be of fully solid-state design
- 5.1.16 Tenderers are to submit their recommendations for earthing of the equipment.
- 5.1.17 All the miscellaneous items such as plugs, connectors and cables necessary for a complete installation, must be supplied with the equipment.
- 5.1.18 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
- 5.1.19 The repeater must be able to reverse the operating channels e.g. Tx low and Rx high and Tx high and Rx low
- 5.1.20 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.
- 5.1.21 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.
- 5.1.22 Tenderers must state the DC current consumption at the nominal operating voltage of all equipment offered under transmit, receive and stand-by conditions
- 5.1.23 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

- 5.1.24 All parameters shall be measured as specified in the controlled document TECHNICAL SPECIFICATION AND METHODS OF MEASUREMENT FOR ANGLE MODULATED RADIO EQUIPMENT. The latest version shall apply.

5.2 TRANSMITTER

- 5.2.1 The transmitter RF power output at the operating voltage as well as the operating frequency, must be as specified in the Schedule of Requirements.
- 5.2.2 The conducted spurious emissions must not exceed a level of -36 dBm
- 5.2.3 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).
- 5.2.4 The audio frequency total harmonic distortion must be =2, 0 % at a modulating frequency of 500 Hz and 1 000 Hz at a modulation factor of 60% of maximum rated system deviation.
- 5.2.5 The angle modulation hum and noise ratio must be at better than 34 dB.
- 5.2.6 The maximum frequency deviation shall not exceed the values as indicated:
- Modulating frequency Maximum deviation
 - 0, 3 to 2, 55 kHz 2, 5 kHz
 - 2, 55 kHz to 6, 0 kHz 2, 5 kHz at a modulating frequency of 2, 55 kHz
 - 0, 75 kHz at a modulating frequency of 6, 0 kHz
 - 6, 0 kHz to 12, 5 kHz 0, 75 kHz having a -14 dB/octave slope
- 5.2.7 The measured and calculated AM hum and noise level must be less than 34 dB.
- 5.2.8 The maximum frequency deviation shall not exceed the values as indicated
- 5.2.9 The power measured at the adjacent channels must be less than 70 dBc

- 5.2.10 The intermodulation attenuation must exceed 40 dB
- 5.2.11 The transmitter shall operate into a 50 Ω impedance antenna system

5.3 RECEIVER

- 5.3.1 The minimum usable sensitivity for a 12 dB SINAD ratio must be -115 dBm or better, without the duplexer
- 5.3.2 The usable sensitivity shall not vary more than 3 dB during extreme conditions (power supply and temperature).
- 5.3.3 The receiver must be provided with an electronic squelch control the sensitivity of which must be adjustable. The squelch closing threshold must be \approx 3, 0 dB below the opening threshold
- 5.3.4 The adjacent channel selectivity and desensitisation ratio must be \approx 70 dB
- 5.3.5 The spurious response attenuation must not be less than 75 dB
- 5.3.6 The intermodulation spurious response attenuation must be \approx 70 dB for a wanted input signal of a level equivalent to usable sensitivity
- 5.3.7 The audio power output into the built-in monitor loudspeaker must be at least 2 watts at less than 5% harmonic distortion
- 5.3.8 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 . It will be stated in the Schedule of Requirements if an audio output is required.
- 5.3.9 The frequency stability must be at least \pm 0, 0005% over the temperature range of -30 $^{\circ}$ C to +60 $^{\circ}$ C (reference temperature +25 $^{\circ}$ C).
- 5.3.10 The modulation acceptance bandwidth must not be \approx 3, 75 kHz.
- 5.3.11 The signal to hum and noise ratio must be \approx 60 dB in the case of a squelched receiver, and \approx 39 dB in the case of an unsquelched receiver
- 5.3.12 Tenderers must state what protection will be provided, and what maximum signals the receiver will be protected against without damage

- 5.3.13 The co-channel rejection ratio must not exceed 12 dB
- 5.3.14 The impedance of the antenna terminal shall be 50 Ω
- 5.3.15 The audio frequency total harmonic distortion must be $\leq 2,0\%$ at a modulating frequency of 500 Hz and 1 000 Hz with a modulation factor of 60% of maximum rated system deviation. Standard RF input signal level is -60 dBm.
- 5.3.16 The conducted spurious radiation must be ≤ -57 dBm
- 5.3.17 The blocking shall be ≥ 84 dB.
- 5.3.18 The amplitude characteristics shall be ± 3 dB
- 5.3.19 The receiver shall retain its selectivity for high RF signal levels up to -7 dBm.
- 5.3.20 Squelch closing time - the audio level shall reduce with 10 dB from the standard output power (nominal -10 dBm) within 250 mS from the time the carrier ceased.

5.4 THROUGH SIGNALS

- 5.4.1 The audio output power measured at the demodulator must not vary more than ± 3 dB (with de-emphasis and pre-emphasis) or ± 2 dB (without de-emphasis and pre-emphasis) when the modulating frequency is varied between 300 Hz to 3 000 Hz with a standard RF input signal.
- 5.4.2 Modulation factor linearity. The modulation factor measured at the transmitter must not vary with more than $\pm 0,1$ kHz from a standard RF signal input with a modulation factor varying from 20% to 100% of maximum rated system deviation, at the receiver. The modulating frequency must be 1 000 Hz. Standard RF input signal level is -60 dBm.
- 5.4.3 Response time. The transmit carrier voltage level must reach a value 6 dB below the steady-state value within 300 mS after the receiver received an RF signal which is 12 dB above the usable sensitivity level.
- 5.4.4 The audio frequency total harmonic distortion measured at the transmitter must be $\leq 5,0\%$ at a modulating frequency of 1 000 Hz with a modulation factor of 60% of maximum rated system deviation. Standard RF input signal level at the receiver is -60 dBm
- 5.4.5

5.5 ANTENNA DUPLEXER

- 5.5.1 The repeater equipment must be supplied complete with antenna duplexer to obviate the use of two antennas
- 5.5.2 The duplexer must provide at least 80 dB isolation between transmitter output and receiver input to ensure that the receiver performance is not degraded when the equipment is operated in the duplex mode. The tenderer must submit response curves of the antenna duplexer offered
- 5.5.3 The antenna duplexer must be capable of handling the transmitter radio frequency power output over a temperature range of -10 °C to +60 °C
- 5.5.4 All terminal impedances must be 50 Ω and the voltage standing wave ratio must not exceed 1,5:1.
- 5.5.5 The insertion loss must not exceed 1,2 dB in both the transmit and receive paths.
- 5.5.6 The tenderer must state the "drift" in the tuning, over the temperature range of -10 °C to +60 °C.

6. QUALITY OF MATERIALS

- 6.1 Preference will be given to manufacturers who guarantee that they comply with the provisions of the code of practice for quality management systems as set out in ISO 9000.
- 6.2 Tenderers must note that the technical personnel of Transnet will carry out inspections to determine whether the code of practice has been adhered to.
- 6.3 Tenderers must submit details of procedures they intend to adopt to comply with ISO 9000.
- 6.4 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.
- 6.5 Mounting screws, where used, must not be self-tapping. Bushes and threaded inserts must be used.
- 6.6 All covers, jacks, sockets etc. must be provided with adequate seals.

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- 6.7 Indication lamps must be rated for reliable long life and must be protected against surges where necessary. Pilot indicator lamps must be light emitting diode (LED) types.
- 6.8 Printed wiring boards must be of epoxy glass fibre laminate or better. Phenolic paper or bakelised paperboards are not acceptable
- 6.9 Printed wiring boards must be properly washed and, if necessary, neutralised after the etching process so that no hygroscopic crystals remain in the board or printed wiring
- 6.10 Printed wiring boards must be guaranteed not to promote or permit the growth of fungi under any conditions.
- 6.11 Printed wiring boards must be fitted with robust plugs and sockets or another approved manner of connecting the boards reliably to the wiring. Edge connectors may be used provided that:
- 6.11.1 A suitable tolerance for the correct fitting of the board between guides and the wiring socket can be guaranteed
 - 6.11.2 Sufficient contact area is provided to guarantee reliable contact.
 - 6.11.3 Sufficient contact pressure is provided to ensure contact but not to remove precious metal from the contacts
 - 6.11.4 In the final protective coating of the boards, no varnish or other protective material is permitted to cover the contacts.
 - 6.11.5 After 500 insertions and withdrawals, there must be no noticeable deterioration of the contacts of either the board or socket.
- 6.12 All printed wiring board sockets, plugs or edge connectors must be gold plated or better.
- 6.13 Heavy components must not be mounted on printed wiring boards unless it can be guaranteed that the board will stand up to severe handling without fracturing with the components so mounted.
- 6.14 No unmarked and/or untested components may be used.
- 6.15 Only new components must be used.
- 6.16 All subassemblies and printed circuit boards must be permanently marked with an identification code.

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- 6.17 Test points must be provided on all units, subunits and printed circuit boards for the measurement of all important circuit characteristics without the unsoldering of wires. Such test points must be clearly marked and identified in the equipment.
- 6.18 All wiring and terminations between subassemblies must be identified.
- 6.19 No printed circuit board must have terminations to points other than the edge of the printed circuit board.
- 6.20 No termination must have more than one conductor per solder joint
- 6.21 Soldering direct to the chassis of any equipment will not be permitted. All chassis terminations must be made with soldering tags.
- 6.22 All pre-set variable controls must be clearly marked and readily identified in the equipment.
- 6.23 Terminations on printed circuit boards must not be made direct to the printed wiring. Where edge connectors are not used, termination to printed wiring must be made via terminal posts.
- 6.24 Where different metals are used in conjunction with each other, tenderers must explicitly guarantee that no electrolytic corrosion must occur under operating conditions
- 6.25 The equipment must be solid state throughout
- 6.26 All components used must be types, which can be readily obtained from local stocks.
- 6.27 The equipment must be built in such a manner that faulty modules can be easily and quickly detected, removed and replaced, but steps must be taken to minimise unnecessary movement of plug-in modules on a trial and error basis when locating faults.
- 6.28 Solid-state devices are to be so constructed that they may be easily tested for correct functioning without having to disturb wiring.
- 6.29 The number of component types must be kept to a minimum consistent with good design of the equipment.
- 6.30 Solid-state boards must be provided on a plug-in or other approved basis so that they can, when necessary, be readily removed for repairs.
- 6.31 Full details of the types of lamps and lenses offered must be furnished with the tender.

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- 6.32 The functions of all controls, switches, etc. must be clearly engraved or otherwise permanently marked by means of approved symbols in English.
 - 6.33 All components must be suitably rated for the function they have to perform without interference to neighbouring material.
 - 6.34 Resistors and restive components must not rise in temperature so that mounting boards or markings thereon are burnt or discoloured.
 - 6.35 Fuses must be rated to give adequate protection to the circuit served while not rupturing prematurely.
 - 6.36 The equipment layout must be planned to facilitate fault clearance and maintenance.
 - 6.37 All components must be clearly marked and must be capable of easy reference to circuit diagrams and handbooks that are supplied with the equipment.
 - 6.38 Equipment using plug-in modules must be fitted with guides for the insertion of modules. It must not be possible to incorrectly insert a module.

7. ACCEPTENCE TESTS

- 7.1 Transnet will conduct acceptance tests on the equipment. The equipment will not be accepted nor payment 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 Freight Rail
- 7.2 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.

8. MAINTENECE 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 Freight Rail 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 compact disc is acceptable.
- 9.3 The technical handbooks must be packed with the equipment.
- 9.4 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, 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.
- 9.7 Transnet freight Rail 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 Freight Rail

10. ALARMS

10.1 Transmitter Alarms

10.1.1 Tx SWR alarm

10.1.2 Tx Low Power alarm.

10.2 Power supply Alarms

10.2.1 Mains failure.

10.2.2 Battery Low Non-urgent and Urgent Alarms depending on supply voltage used are as follows:

10.2.2.1 for 12 volt system.

10.2.2.1.1 Low Non-urgent alarm is 12 volt.

10.2.2.1.2 Low urgent alarm is 11 volt.

10.2.2.2 for 24 volt system.

10.2.2.2.1 Low Non-urgent alarm is 24 volt.

10.2.2.2.2 Low urgent alarm is 22 volt.

10.2.2.3 for 48 volt system.

10.2.2.3.1 Low Non-urgent alarm is 48 volt.

10.2.2.3.2 Low urgent alarm is 43 volt.

11. POWER SUPPLY

Should the equipment be supplied with a mains power supply/charger, the battery charging circuit must be provided with load shed?

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.

END OF DOCUMENT

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