STORNO RADIOCOMMUNICATION

TECHNICAL REQUIREMENTS

FOR LANDMOBILE VHF EQUIPMENT

FOR 25 kc/s CHANNEL SEPARATION

Storno

TECHNICAL REQUIREMENTS

FOR LANDMOBILE VHF EQUIPMENT

FOR 25 kc/s CHANNEL SEPARATION

Introduction

Re: Technical requirements for landmobile
VHF equipment for 25 kc/s channel separation.

Many European countries are now introducing 25 kc/s channel separation on the VHF bands because of the ever increasing demand for more landmobile services.

STORNO have been producing mobile and fixed equipment for narrow band operation since the spring of 1960. During the development work, we had to examine carefully all existing specifications for such equipment. We found that no International standardisation existed. Measuring methods and conditions, definitions and requirements, differ from country to country and a direct comparison is difficult.

In the following, we have tried to compare the American (EIA), the British (GPO), and the Swedish specifications. This has been done, mainly, by using the EIA methods of measurements and then comparing the various requirements.

The specifications from Sweden and England apply to angle modulated equipment on the 80 Mc/s band operating with a channel separation of 25 kc/s. We are informed, however, that the GPO will soon issue specifications for the 160 Mc/s band and that these will be identical with the demands for the 80 Mc/s band. The EIA specifications differ for the frequency bands only with regard to the receivers and the difference is not significant.

CONTENTS:

FM
80 Mc/s
25 kc/s

Comparison of the existing technical specifications for land mobile equipment with 25 kc/s channel separation.

GPO. W 6289, General Post Office, England.
Specification for Angle Modulated Transmitter-Receivers (Fixed and Mobile) for 25 kc/s Carrier Frequency Separation and Maximum Deviation up to ± 5 kc/s, 1959.

EIA. Electronic Industries Association (former RETMA), USA.
RS-152. Minimum Standards for Land-Mobile Communication FM or PM Transmitters 25-470 MC. April, 1956.
RS-204. Minimum Standards for Land-Mobile Communication FM or PM Receivers. January 1958.

SWE. Kungl. Telestyrelsen, Radiobyrån, Sweden.
Tekniska bestämmelser för landmobila radioanläggningar i frekvensband med 25 kHz kanalindeling, utfärdade i februari 1959. (Technical specification for landmobile radio equipment in the 68-88 Mc/s band, with 25 kc/s channel separation. Published in Feb. 1959).

These specifications differ in several points and in the following table a cross indicates that the particular Authority have specified a condition to which the equipment must conform.

TRANSMITTER	GPO	EIA	SWE
1. Carrier Power Output		X	X
2. Carrier Frequency Stability	X	X	X
3. Modulation Characteristics	X	X	X
4. Modulation Distortion		X	
5. Modulation Limiting	X	X	X
6. Hum & Noise Level		X	
7. Sideband Noise Level	X	X	
8. Harmonic Radiation	X	X	X
9. Spurious Radiation	X	X	X
10. Chassis Radiation	X		
11. Primary Power		X	
12. Temperature Range	X	X	X
13. Influency of Humidity		X	
14. Vibration Stability		X	
15. Shock Stability		X	

RECEIVER			
1. Frequency Stability			X
2. Sensitivity	X	X	
3. Selectivity	X	X	X
4. Acceptance bandwidth		X	
5. Blocking	X		
6. Cross-modulation	X		
7. Intermodulation	X	X	X
8. Spurious Response Attenuation	X	X	X
9. Audio Frequency Output		X	

FM
80 Mc/s
25 kc/s

		GPO	EIA	SWE
10.	Audio Frequency Characteristics		X	
11.	Hum & Noise Level		X	
12.	Squelch Sensitivity		X	
13.	Spurious Radiation	X	X	X
14.	Chassis Radiation	X	X	
15.	Primary Voltage		X	
16.	Temperature Range	X	X	X
17.	Influence of Humidity		X	
18.	Vibration Stability		X	
19.	Shock Stability		X	

SPECIFICATIONS

These points are dealt with in detail below, first actual figures are quoted for each point for all specifications where there is a figure and method of measurement given, followed by comments on these figures taken point by point.

TRANSMITTERS

1. CARRIER OUTPUT POWER

GPO: No requirement

EIA:		Voltage Variation	Temp. °C	Humidity
	may fall by max. 3dB at	0%	-30° +60°	-
	may fall by max. 3dB at	0%	(50°)	90%
	may fall by max. 3dB at	±10%	room temp.	-
	may fall by max. 10dB at	-20%	room temp.	-

SWE: max. 100 watt E.R.P., generally as low as possible.

2. CARRIER FREQUENCY STABILITY

	88 Mc/s ± kc/s	± %	68 Mc/s ± kc/s	± %	Voltage Variation		Temp. °C		Humidity
GPO:	3.00	0.0034	3.00	0.0044	-10%	+10%	-10°	+40°	-
EIA:	2.64	0.003	2.04	0.003	-10%	+10%	(50°)		90%
SWE:	1.76	0.002	1.36	0.002	-15%	+10%	-25°	+40°	-

3. MODULATION CHARACTERISTICS

	300 - 3000 c/s	over 3000 c/s
GPO:	no requirement	from 6000 to 20.000, -15dB/octave max. deviation ±1,5 kc/s at 6000 c/s
EIA:	+6dB/octave	no requirement
SWE:	no requirement	from 2500 c/s to 12.500 c/s, -12dB/octave max. deviation -28dB at 12.500, c/s rel to 1kc

4. MODULATION DISTORTION

GPO: No requirement.
EIA: Max. 10%.
SWE: No requirement.

5. MODULATION LIMITING

GPO: Measured as Sideband Noise (See point 7).
EIA: Max. 5 kc/s, with 20dB increase on 3.3 kc/s deviation.
SWE: Max. 5 kc/s, with 20dB increase on 3.3 kc/s deviation.

6. HUM & NOISE LEVEL

GPO: No requirement. (Covered by point 3).
EIA: FM noise, -40dB rel. 3.3 kc/s Deviation.
AM noise, -34dB rel. carrier wave level.
Not to be degraded more than 6dB between -30°C and +60°C.
Not to be degraded more than 6dB with 90% humidity at 50°C.
SWE: No requirement.

7. SIDEBAND NOISE LEVEL

GPO: -59dB. (EIA method).
EIA: -56dB. for 10 watt transmitter, unmodulated, dependent on PA input.
SWE: No requirement.

8. HARMONIC RADIATION

GPO: Max. 2.5 µW, independent of transmitter output.
EIA: Max. 1o µW, for a 10 watt transmitter, dependent on PA input.
SWE: Max. 20 µW, independent of transmitter output.

9. SPURIOUS RADIATION

GPO: Max. 2.5 µW, independent of transmitter output.
EIA: Max. 1C µW for a 10 watt transmitter, dependent on PA input.
SWE: Max. 0.2 µW, independent of transmitter output.

10. CHASSIS RADIATION

GPO: Lowest possible.
EIA: No requirement.
SWE: No requirement.

11. PRIMARY POWER

GPO: To be stated by the manufacturer, measurements at ±10%.
EIA: Nominal 6.5 - 13.6 - 24.6 volt (depending on consumption).
All requirements shall be satisfied with a variation of ±10%.
The equipment shall be able to start at -20%.
SWE: No requirement, measurements at -15% +10%.

12. TEMPERATURE RANGE

GPO: -10° to +40°C. (50°C Variation).
EIA: -30° to +60°C. (90°C Variation).
SWE: -25° to +40°C. (65°C Variation).

13. INFLUENCE OF HUMIDITY

GPO: No requirement.
EIA: 90% humidity at 50°C for 8 hours.
SWE: No requirement.

14. VIBRATION STABILITY

GPO: No requirement.
EIA: Vibration test with the equipment in operation.
SWE: No requirement.

15. SHOCK STABILITY

GPO: No requirement.
EIA: 20g tests with the equipment in operation.
SWE: No requirement.

RECEIVER

1. FREQUENCY STABILITY

GPO: No requirement.
EIA: No requirement.
SWE: ±0.002% within a temperature range -25°C to +40°C and a primary voltage variation of -15% to +10%.

2. SENSITIVITY

a) Signal/noise measurement (EIA method).
GPO: Max. approx. 1.6 µV.
EIA: Max. approx. 1.2 µV.
Max. 3dB higher at ±10% voltage variation.
max. 6dB higher within -30° to +60°C.
max. 10dB higher with 90% humidity at 50°C.
SWE: No requirement.

b) "Noise Quieting" method.
GPO: No requirement.
EIA: Max. approx. 1.2 µV for 20 dB noise quieting.
SWE: No requirement.

3. SELECTIVITY

Two-signal method.

GPO: Max. approx. 76dB may fall 10dB for all combinations of temperature range -10° to +40°C.
voltage variation of ±10%.
EIA: Min. 70dB.
may fall by 12dB for -30°C +60°C.
may fall by 20dB at a humidity of 90% at 50°C.
SWE: Min. 80dB.

4. ACCEPTANCE BANDWIDTH

GPO: No requirement.
EIA: Min. ±5 kc/s. Measured as modulation acceptance bandwidth.
Min. ±4 kc/s for -30°C +60°C.
Min. ±4 kc/s for 90% humidity at 50°C.
SWE: No requirement.

5. BLOCKING

GPO: 100 millivolts for all frequencies outside F_o ±150 kc/s.
EIA: No requirement. (partly covered by selectivity measurement).
SWE: No requirement. (partly covered by selectivity measurement).

6. CROSS MODULATION

GPO: 3mV/100mV, for all frequencies outside F_o ±150 kc/s.
EIA: No requirement.
SWE: No requirement.

7. INTERMODULATION

Reference Level		20µV	200µV
GPO:	(EIA method) Min. approx. 58dB	40dB	30dB
EIA:	Min. 50dB	40dB	30dB
SWE:	Min. 70dB	- No requirement -	

8. SPURIOUS RESPONSE ATTENUATION

Measured by EIA method.
GPO: Min. Approx. 80dB.
EIA: Min. 85dB.
SWE: Min. 70dB.

9. AUDIO FREQUENCY OUTPUT

GPO: No requirement.
EIA: Min. 1 watt. Max 15% distortion.
Max. of 3dB less with ±10% voltage variation.
Max. of 2dB less from -30°C to +60°C.
Max. of 3dB less with humidity 90% and 50°C.

10. AUDIO FREQUENCY CHARACTERISTICS

GPO: No requirement.
EIA: +6dB/octave, max. variation +2/-8 dB, 300 to 3000 c/s.
SWE: No requirement.

11. HUM & NOISE LEVELS

GPO: No requirement.
EIA: At least 40dB with 3.3 kc/s deviation.
May fall by 10dB within -30°C to +60°C.
May fall by 10dB with 90% humidity at 50°C.
SWE: No requirement.

12. SQUELCH SENSITIVITY

GPO: No requirement.
EIA: Max. approx. 0.6 µV emf.
May rise 3dB with ±10% voltage variation.
May rise 6dB for -30°C to +60°C.
May rise 10dB with 90% humidity at 50°C.
SWE: No requirement.

13. SPURIOUS RADIATION

GPO: Max. 0.02 µW.
EIA: Requirement not known. (FCC Stipulation).
SWE: Max. 0.01 µW.

14. CHASSIS RADIATION

GPO: Lowest possible.
EIA: Requirement not known.
SWE: No requirement.

15. PRIMARY POWER

GPO: To be stated by the manufacturer, measurements at ±10%.
EIA: Nominal 6.6 - 13.8 - 24.6 depending on consumption.
SWE: No requirement, measurements at -15% +10%.

16. TEMPERATURE RANGE

GPO: -10° to +40°C. (50° variation).
EIA: -30° to +60°C. (90° variation).
SWE: -25° to +40°C. (65° variation).

17. INFLUENCE OF HUMIDITY

GPO: No requirement.
EIA: 90-95% humidity at 50°C.
SWE: No requirement.

18. VIBRATION STABILITY

GPO: No requirement.
EIA: Vibration test with equipment in operation.
SWE: No requirement.

19. SHOCK STABILITY

GPO: No requirement.
EIA: 20g tests with the equipment in operation.
SWE: No requirement.

COMMENTS ON THE SPECIFICATIONS

TRANSMITTER

1. Carrier Output Power

EIA carry out measurements of output power after 8 hours operation with 1 min. "on", 4 mins. "off" and then three periods with 5 mins. "on" and 15 mins. "off".
SWE specify a maximum antenna height of 50 meters.

2. Carrier Frequency Stability

The requirement can be satisfied by the use of good quality crystals without an oven.
For FIXED stations, the following stability is required:
GPO: ±1.5 kc/s.
SWE: ±0.001%.

3. Modulation Characteristic

GPO and SWE do not require +6dB/octave in the 300 to 3000 c/s range. Later American recommendations request -12 dB/octave above 3000 c/s.

4. Modulation Distortion

No comments.

5. Modulation Limiting

GPO request a rather complicated measurement of sideband noise (see point 7) which will show up any defective modulation limiting.

6. Hum & Noise Level

GPO lay down no direct requirement for hum and noise, but the measurement of modulation characteristics (point 3) from 6000 to 20000 c/s cannot be carried out satisfactorily if the noise level is higher than -35 to 40 dB.

7. Sideband Noise

GPO measure sideband noise 25 kc/s away from the transmitter frequency with the transmitter modulated with 300 c/s +15 dB (relative to 50% modulation) 1500 c/s at +10 dB and 3000 c/s at 0 dB. There must be no more than 12 µW noise power in the neighbouring channel.
EIA measure with an unmodulated transmitter. The requirement is -56dB for transmitters with a PA input between 3 and 25 watts. For a 10 watt transmitter, the sideband noise power may be max. -46dB.
12 µW corresponds to approximately -49 dBW. If the modulation limiting is perfect, the sideband noise will be independent of the modulation, and GPO's requirement corresponds to a 59 dB attenuation relative to 10 watts level.

The GPO's method is very effective in revealing inadequate modulation limiting.

8. Harmonic Radiation

The GPO define "spurious emissions" as all unwanted radiations from transmitters outside $f_o \pm 50$ kc/s and have fixed a maximum level of 2.5 µW independent of transmitter power.
EIA differentiate between harmonic and other spurious radiations and make requirements relative to PA input. For transmitters with 3 to 25 watts input, 60 dB attenuation is required for both harmonic and spurious radiation.
SWE also differentiate between harmonic and spurious radiations, but rate their requirements with respect to 20 and 0.2 µW, independent of transmitter output power.
Radiations are always measured at antenna terminals with the transmitter normally loaded and no account is taken of the radiation efficiency of the antenna under normal working conditions.

9. Spurious Radiation

See under point 8.

10. Chassis Radiation

No requirement, but GPO mention that the manufacturer is responsible for ensuring that the chassis, leads, etc. do not give rise to troublesome radiation.

11. Primary Power

Both the GPO and the EIA make measurements with ±10% voltage variation while SWE make measurements at +10% and -15%.

12. Temperature range

No comments.

13. Influence of Humidity

After 8 hours in a chamber held at a specific temperature and pressure (without power applied to the set). EIA measure power output, hum and noise level and frequency stability.

14. Vibration Test

EIA state that the transmitter shall satisfy all requirements while under test. The hum and noise level may be 10 dB worse under these conditions.

15. Shock tests

EIA state that the transmitter should satisfy all requirements after it has been subjected to not less than 10 shocks of 10g in each plane or a minimum of thirty in all. The transmitter is switched on during the last half of each test.

RECEIVER

1. Frequency Stability

Only SWE specify a requirement for the frequency stability of receivers. There have been many discussions at the Swedish Post Office on the subject of a defining receiv r frequency stability and at the time of writing is no agreement has been reached. From practical considerations, however, the stability may be judged with respect to the stability of the crystal oscillator, IF amplifier and discriminator.

2. Sensitivity

There are three different methods of measuring sensitivity

"a" GPO measure $\frac{S + N_{sm} + D}{N_{su}}$

"b" EIA measure $\frac{S + N_{sm} + D}{N_{sm} + D}$

"c" and "quieting method" N/N_{su}

where,

S = = Level of a demodulated tone (1000 c/s)

N_u = Level of noise without RF signal. (unmodulated)

N_{su} = Level of noise with RF signal without modulation. (unmodulated)

N_{sm} = Level of noise with RF signal and modulation.

D = Level of noise from distortion products.

The GPO measure with a very small deviation of 0.5 kc/s and a signal-to-noise ratio of 10dB. Referring to "a", this means that the RF signal shall be less than 4μV emf. The EIA measure with a deviation of 3.3 kc/s and a signal-to-noise ratio of 12dB as under "b" and a RF signal less than 1.2 μV emf. (This last figure is interpolated from 1 μV for 40 Mc/s and 2 μV for 160 Mc/s).

In actual practice a receiver which just passes the GPO test has a sensitivity of 1.6 μV when measured by the EIA method.

3. Selectivity

The methods of measurement of the three Authorities are the same, but the test signals and the requirement are different. GPO measure with 23.5 and not with 25 kc/s, with an interference signal modulated both AM and FM and also under all combinations of voltage and temperature variations.

The measurement shows that a receiver that just passes the GPO's test with the normal voltage and at room temperature, has a selectivity attenuation of 76dB when measured by the EIA method.

4. Acceptance Bandwidth

Only EIA have requirements on acceptance bandwidth. A signal modulated with 1000 c/s and with 3.3 kc/s deviation is fed to the receiver at a RF level to give 12 dB signal-to-noise ratio. The RF level is increased 6dB and the deviation is increased until the signal-to-noise ratio is back to 12dB.

This simple measurement is most illuminating and especially useful when measuring narrow band equipments. It is a temptation for manufacturers to increase the selectivity with respect to adjacent channels at the expense of the bandwidth at the top of the curve, and the sensitivity measurement (with reduced deviation) on a receiver with a bandwidth which is too narrow at the top will not give the correct expression for its usefulness in practice.

5. Blocking

Only the GPO have a requirement for this, but for EIA's and SWE's part, selectivity measurements can not be carried out satisfactorily if the receiver has a tendency to blocking at the operating level.

6. Cross-Modulation

Only the GPO give a method of measurement and state a requirement.

7. Intermodulation

The method of measurement is the same as the method for selectivity, but the test signals and the specifications are different.
Practical results show that a receiver which has just satisfied the GPO requirement on intermodulation will have a intermodulation attenuation of 58dB, when the measurement is carried out by the EIA method, with the wanted signal at the sensitivity limit. The corresponding requirement from EIA is 50dB. For 20 and 200 µV wanted signal, the requirement is the same for the GPO and EIA, measured by the EIA method. SWE measure by the EIA method, but specify 70 dB intermodulation attenuation.

8. Spurious Response Attenuation

GPO reference level is a modulated standard test signal which gives 10dB signal-to-noise ratio while EIA's reference is 20dB "noise quieting". Similar measurements show that the GPO requirement corresponds to approx. 80dB by the EIA method.
SWE measure by the EIA method but specify 70dB.

9. Audio Frequency Output

No comments.

10. Audio Frequency Characteristics

As with transmitters GPO and SWE have no requirement for the characteristic in the speech range.

11. Hum & Noise Level

No comments.

12. Squelch Sensitivity

No comment.

13. Spurious Radiation

EIA refer to "F.C.C. rules, part 15, subpart C".

14. Chassis Radiation

As for "13".

15. Primary Power

GPO and EIA carry out measurements with ±10% voltage variation, while SWE carry out measurements at +10% and -15%.

16. Temperature Range

No comments.

17. Influence of Humidity

After 8 hours under controlled conditions (without voltage applied), EIA measure sensitivity, squelch, bandwidth, selectivity, LF output and hum & noise level.

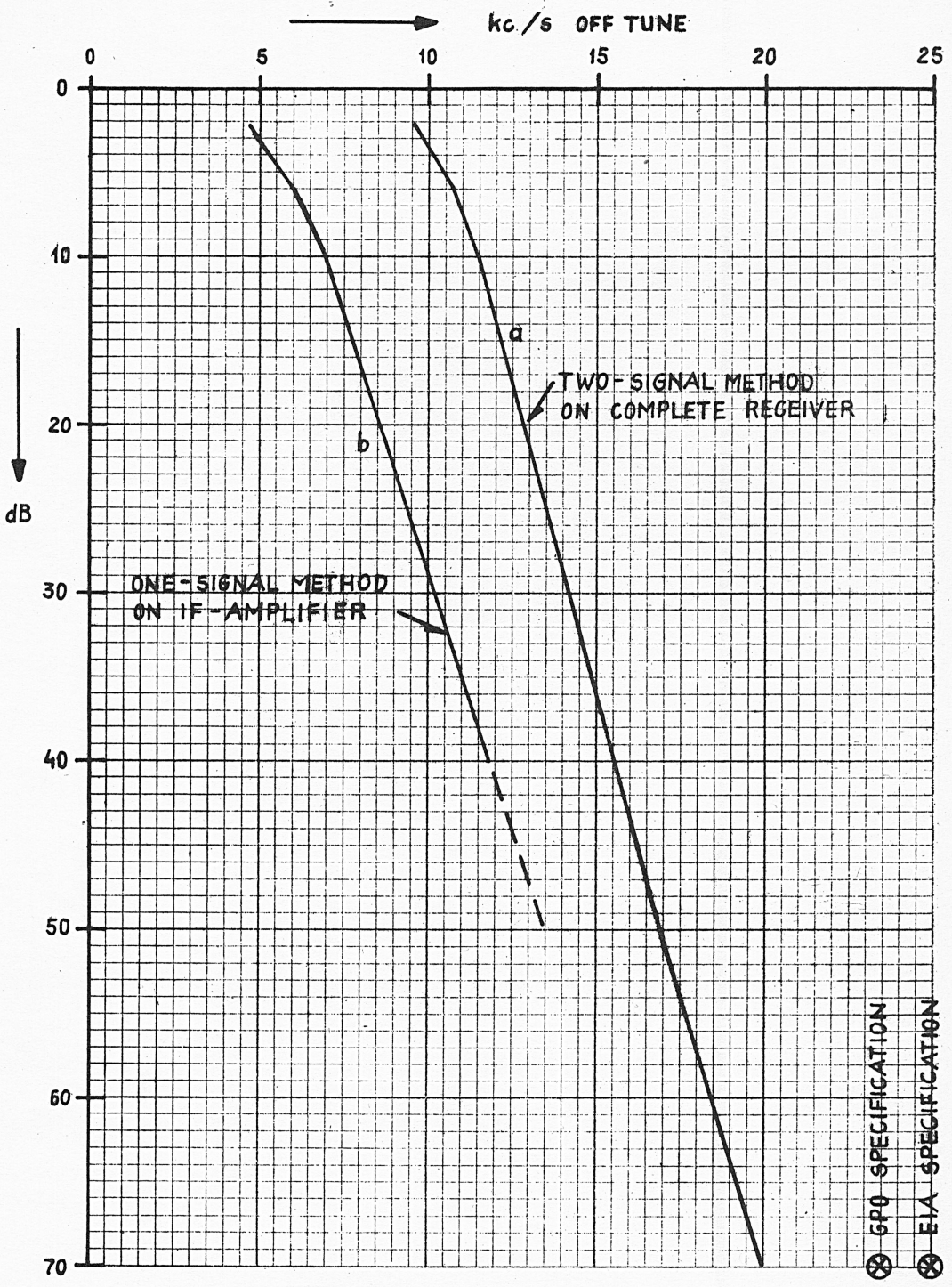
18. Vibration Stability

EIA state that all requirements shall be satisfied under vibration test conditions.

19. Shock Stability

EIA state that all requirements shall be satisfied after 10 shocks in every plane of 20g each with the receiver operating.

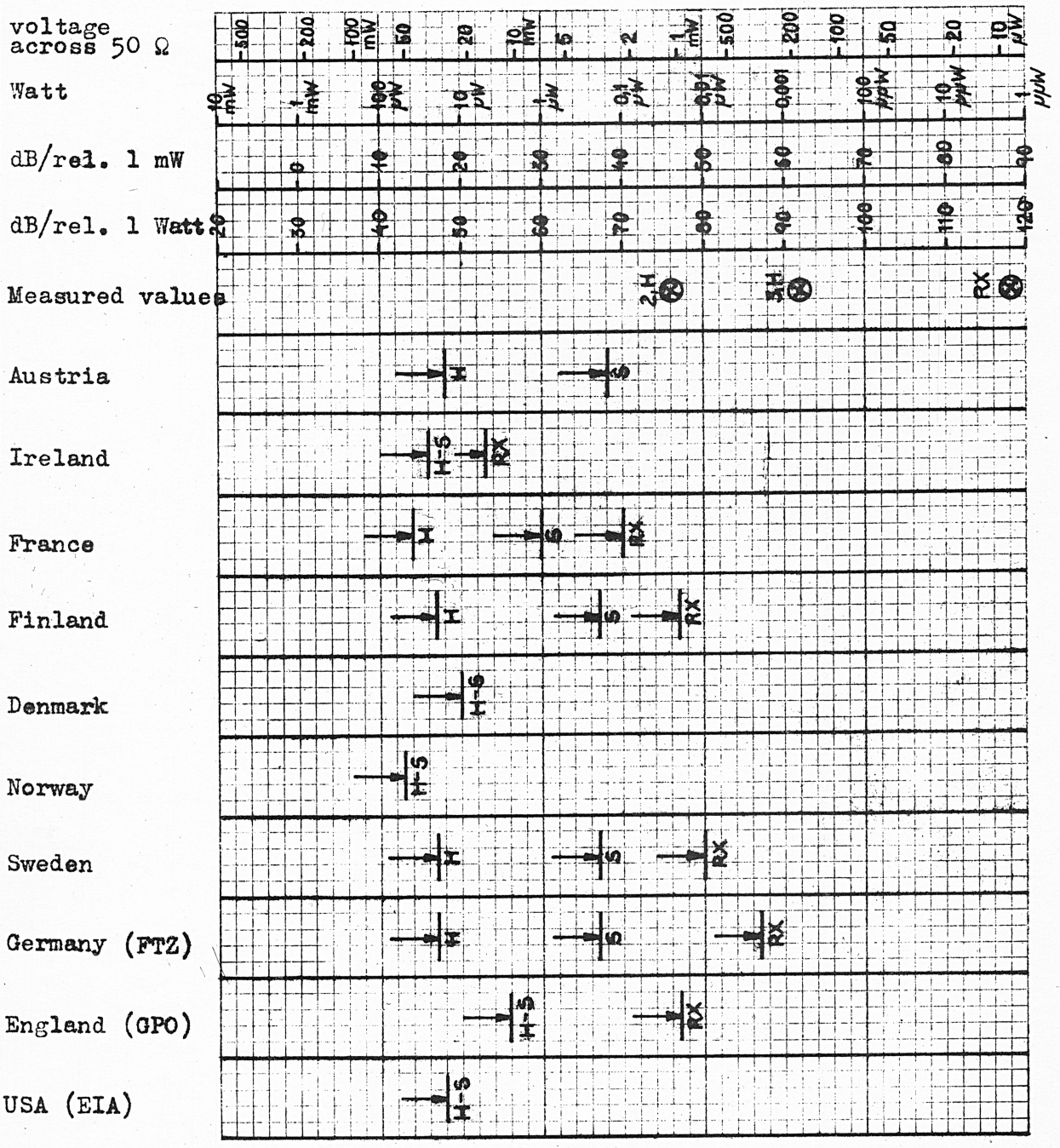
Selectivity measured on a standard STORNOPHONE mobile radiotelephone designed for 25 kc/s channel spacing. Measurements are made on a 160 Mc/s equipment but the same characteristic applies to 80 Mc/s equipment.



"Curve "a": Two signal method according to EIA STANDARD RS-204, point 7.

Curve "b": One-signal method with first limiter grid current as reference

Modulation acceptance bandwidth measured according to EIA STANDARD RS-204, point 6 is 7 kc/s.



Specified maximum level of harmonic (H) and spurious (S) radiation from mobile VHF transmitters and spurious radiation from mobile VHF receivers (RX)
In cases where the administrations specify a certain level below the power radiated from the transmitter the power level has been taken as 15 watts (+12 dB/W).

Storno

w 6289

Private Metric (V.H.F.) Mobile Radio Telephone Services.

Specification for Angle Modulated Transmitter-Receivers (Fixed and Mobile) for 25 kc/s Carrier Frequency Separation and Maximum Deviation up to ± 5 kc/s

CONTENTS

1. General Requirements

1.1 *Scope of Specification*

1.1.1 *General.* This Specification covers the minimum mandatory requirements of angle-modulated transmitter-receivers for use in connexion with metric (VHF) mobile radio-telephone services which are not connected in any way with the public telephone system, and does not apply to hand portable equipment. For equipment covered by this Specification, the nominal separation between adjacent channel carrier frequencies is 25 kc/s and maximum deviation (angle-modulation) up to ±5 kc/s is permitted.

1.1.2 *Licensee's Responsibility.* The installation of equipment, either fixed or mobile, is subject to the issue of a licence by the Postmaster General. Under the conditions of the licence it will be the responsibility of the licensee to ensure that the equipment provided conforms with, and is maintained to, the requirements of this Specification.

1.1.3 *Type Tests.* Manufacturers will be required to submit a sample of equipment of each type to the Engineer-in-Chief, WI Branch, GPO, London, EC2, for type testing before such equipment may be installed. This Specification is to be regarded as forming the basis for the type tests. The type testing, or a portion thereof, may be required by the Engineer-in-Chief to be carried out at the Manufacturers' Works. The provision of the necessary test equipment shall be subject to agreement between the Engineer-in-Chief and the Manufacturer concerned.

1.2 *Operating Frequencies.* The equipment should transmit on one or more carrier frequencies in the range 71·5 Mc/s to 88 Mc/s and receive on one or more carrier frequencies in the same range; the precise frequencies will be quoted by the Postmaster General when a licence is issued. For type testing the equipment shall preferably transmit and receive on a frequency of 88 Mc/s. Where

tests on other frequencies are required, this shall be by agreement between the Manufacturer and the Engineer-in-Chief; in this case the Manufacturer may be required to supply test equipment approved by the Engineer-in-Chief. For type testing of switched channel equipment, the highest frequency channel shall operate on 88 Mc/s.

1.3 *Controls.* Those controls which if maladjusted might increase the interfering potentialities of the equipment shall not be accessible to the operator.

2. Standard Test Conditions

2.1 *General.* Standard test conditions are those conditions which shall apply to a transmitter or receiver for the purpose of testing for the minimum requirements according to this Specification.

2.2 *Test Voltage.* The standard test voltage shall be the primary voltage applied to the input end of the power cable normally connected to the equipment. It shall be within ±2 per cent of the value stated by the Manufacturer to be the nominal working voltage.

2.3 *Atmospheric Conditions.* The standard atmospheric conditions for testing are the average temperature, humidity and pressure of the atmosphere in which the equipment will be tested. They shall lie between the following limits during the whole period of the test except when otherwise specified:—

Temperature	15° C to 30° C
Relative Humidity	45 per cent to 75 per cent
Air Pressure	930 to 1060 mbar (700 to 800 mm of mercury)

Note:—Where it is impracticable to carry out the tests under the standard atmospheric conditions for testing a note to this effect, stating the actual conditions of test, shall be added to the test report.

2.4 *Transmitter Modulation.* For standard tests, the deviation of the transmitter carrier shall be one half ±5 per cent of the maximum deviation quoted by the manufacturer for a sinusoidal tone of frequency 1000 c/s and a sinusoidal tone of 1000 c/s shall be used to modulate the transmitter. The total harmonic distortion of the test modulation shall not exceed 2 per cent.

2.5 *Transmitter Output Load.* The transmitter standard test load shall be a non-reactive resistance equal to the nominal load resistance of the transmitter as declared by the Manufacturer. The standard test load shall be so designed that the power lost by direct radiation is negligible.

2.6 *Transmitter Output Loading.* The transmitter standard test loading and the method of achieving it shall be as specified by the Manufacturer.

2.7 *Receiver Test Signal.* The standard test signal to be applied to the receiver shall be frequency modulated by a sinusoidal tone of frequency 1000 c/s, with a deviation of 30 per cent of the maximum deviation at 1000 c/s, which shall be quoted by the Manufacturer. The total harmonic distortion of the test modulated signal shall not exceed 2 per cent and it shall be substantially free from amplitude modulation.

2.8 *Receiver Test Signal Input Arrangements*

2.8.1 *Single Signal.* The standard input network for the application of a single signal to the input of a receiver shall be a non-reactive resistor connected (when necessary) in series with the signal generator and of such a value that, when added to the nominal output impedance of the signal generator, the total equals the nominal input impedance of the receiver to be tested (which shall be declared by the Manufacturer). The open circuit output voltage of the signal generator at any given setting shall be regarded as the level of signal applied to the receiver under test.

2.8.2 *Two or Three Simultaneous Signals*

(*a*) Each signal generator shall have a non-reactive resistor connected in series with its output, in accordance with Section 2.8.1 above.

(*b*) The standard combining arrangements for the simultaneous application of two or three signals to the input of a receiver shall be equivalent to the use of a screened star network formed by connecting together one end of each of four equal resistors. Each resistor shall be equal in value to one half the nominal input impedance of the receiver to be tested (which shall be declared by the Manufacturer) and the outer ends of the star network shall be connected to four terminals " A ", " B ", " C " and " D ".

The output of each of the signal generators to be combined shall be connected, via the appropriate resistor according to Clause 2.8.1 above, to one of the terminals " A ", " B " or " C ". Terminal " D " shall be connected to the input of the receiver. If only two signal generators are combined, the unused terminal shall be terminated with a non-reactive resistor equal in value to the nominal impedance of the receiver. The signal levels applied to the receiver shall be regarded as being 10 db below the open circuit output voltages of the generators at any given settings. It is assumed that the generators have equal output impedances. When the impedances are not equal, it is important to ensure that all the nominal impedances are correctly matched, including those of the cables. The method of connexion shall be such that none of the generators interferes with the proper operation of the others.

2.9 *Output Power (Receiver).* The receiver standard power output shall be taken as 10 per cent of the maximum rated output (which shall be declared by the Manufacturer) measured in a resistive load equal to the impedance of the

load normally connected to the receiver (which shall be declared by the Manufacturer).

2.10 *Receiver Sensitivity.* During all tests on the receiver any sensitivity controls available to the user shall be adjusted for maximum sensitivity.

3. Standard Test Receiver

The test receiver used for the modulation limiting test in Clause 4.2.2 shall be tuned to a frequency which is separated by 25 kc/s from that of the transmitter to be tested and shall meet the requirements of Section 5 of this Specification; its IF bandwidth shall also meet the following requirements:—

(*a*) Minimum bandwidth for 6 db rejection of the applied signal. (Measured by a single signal method.) ±5 kc/s

(*b*) Minimum bandwidth for 70 db rejection of the applied signal. (Measured by the two-signal method according to Clause 5.2 below but with the receiver operating under standard test conditions.) ±15 kc/s

4. Transmitter

4.1 *Carrier Power Output.* The carrier power output of the transmitter shall be the maximum power available at the output under the standard test conditions according to Clauses 2.5 and 2.6 above.

4.2 *Modulation*

4.2.1 *Modulation Response*

Method of Test. Standard test modulation at 1000 c/s, according to Clause 2.4 above, shall be applied to the transmitter which shall be operated under standard test loading conditions, according to Clauses 2.5 and 2.6

above. With a constant level of the standard test modulation applied to the transmitter, the modulation frequency shall be varied from 300 c/s to 20 kc/s and the deviation shall be measured.

Minimum Standard. The deviation with any test modulating frequency shall not exceed ±2·5 kc/s and with a test modulating frequency of 6 kc/s shall not exceed ±1·5 kc/s; the deviation shall fall at the rate of 15 db per octave as the frequency of the test modulating signal is increased above 6 kc/s.

4.2.2 *Modulation Limiting*

Method of Test. The interference caused by radiation of sidebands in the adjacent channel is measured with a test receiver in accordance with Section 3 above, using a method similar to the two-signal test for measuring receiver selectivity.

The transmitter and test receiver shall be operated under standard test conditions, according to Section 2 above, and the maximum power output of the transmitter shall be connected via a variable Attenuator " A " together with the output of a Signal Generator " B " to the input of the test receiver, via a combining unit according to Clause 2.8.2 above. Arrangements shall be made to match the transmitter output impedance to the receiver input impedance, if necessary. The output of the test receiver shall be connected to an audio frequency output power meter. Signal Generator " B " and the test receiver shall both be tuned to the same frequency, 25 kc/s above or below the frequency of the transmitter. With the transmitter switched off in a manner which does not alter its output impedance, the level of the standard test signal from Signal Generator " B " shall be adjusted to produce a signal-to-noise ratio of 10 db at the output of the test receiver. The transmitter shall then be switched on and the level of a test modulating

signal at 1500 c/s, which shall be connected to the input of the transmitter shall be increased by 10 db above that required to produce 50 per cent of the maximum deviation of the equipment with a modulating signal frequency of 1500 c/s. The level of the signal from the transmitter at the input of the receiver shall be varied, by means of Attenuator " A ", until either:—

(*a*) the signal-to-noise ratio at the output of the test receiver falls by 3 db, or

(*b*) the audio output of the test receiver, due to the input from Signal Generator " B " falls by 3 db.

The lowest level of signal from the transmitter at the input of the receiver which produces condition (*a*) or (*b*) shall be considered as the criterion for the purposes of this test.

With Signal Generator " B " switched off, in a manner which does not alter its output impedance and the test modulation removed from the transmitter, its carrier level at the input of the receiver shall be evaluated:—

(*a*) by a substitution method, using a Signal Generator " C " and a test receiver both tuned to the frequency of the transmitter, or

(*b*) by measuring the level of the transmitter carrier at the input of Attenuator " A " which shall be calibrated with an error not exceeding ±1·0 db on any setting. In this case, the output of the transmitter shall also be connected via a dummy load arranged so that the unmodulated carrier level of the transmitter at the input to Attenuator " A " can be measured with a VHF valve voltmeter.

The test shall be repeated with the frequency and level of the test modulating signal which is applied to the transmitter as indicated below:—

Frequency of Test Modulating Signal (c/s)	Level of Test Modulating Signal relative to the level required to produce 50 per cent of the maximum deviation of the equipment at a frequency of 1500 c/s (db)
300	-15
3,000	zero

Minimum Standard. The product of the transmitter output power, according to Clause 4.1 above, and the power ratio at the input to the receiver of the signal from Signal Generator " B " to the signal from the unmodulated transmitter, or its equivalent signal from Signal Generator " C ", shall not exceed 12 microwatts.

4.3 *Spurious Emissions.* Emissions at any frequency other than that of the carrier and the sidebands comprising the modulation envelope specified in Clause 4.2 above shall be considered as spurious, irrespective of whether radiation takes place via the aerial or by direct radiation from circuit components and wiring.

4.3.1 *Spurious Signal Power at Aerial Terminals*

Method of Test. The spurious signals shall be measured whilst the unmodulated transmitter is operating with the standard test load and loading conditions according to Clauses 2.5 and 2.6 above.

Minimum Standard. The power of the individual spurious signals at any frequency separated from the carrier by more than 50 kc/s shall not exceed 2·5 microwatts.

4.3.2 *Spurious Radiation.* The emission of spurious frequencies by direct radiation from components and wiring of the transmitter shall be minimized, and the Manufacturer shall be responsible for ensuring that interference is not suffered by other radio users.

In the event of interference being traced to the radiation of spurious frequencies, the Manufacturer shall be required to suppress the interference to a degree which shall be satisfactory to the Postmaster General.

4.4 *Accuracy and Stability of Carrier Frequency*

Method of Test. The carrier frequency shall be measured, in the absence of modulation, with a frequency-meter having an error not exceeding ±0·0001 per cent (±1 part in 10^6).

The transmitter shall be operated under standard test conditions according to Section 2 above but the test voltage shall be changed first to +10 per cent and then to −10 per cent of the value according to Clause 2.2 above. With each of these conditions, measurements shall be made as follows:—

(*a*) The ambient temperature of the transmitter, measured at a point not more than one inch from its case, shall be maintained at −10° C for at least one hour with the equipment switched off. The equipment shall then be switched on in the standby condition for five minutes and the carrier frequency shall be measured.

(*b*) The ambient temperature of the transmitter, measured at a point not more than one inch from its case, shall be maintained at +40° C for at least one hour, the equipment being switched on in the standby condition for the whole of this period. The carrier frequency shall be measured after an unmodulated signal has then been transmitted for five minutes.

Minimum Standard. The maximum departure of the carrier frequency from its nominal value (i.e. that quoted in the licence) shall not exceed:—

(*a*) Fixed Stations: ±1·5 kc/s relative to the nominal carrier frequency.

(*b*) Mobile Stations: ±3·0 kc/s relative to the nominal carrier frequency.

5. RECEIVER

5.1 *General.* The performance figures specified in the following Clauses are for a receiver having an input impedance of 75 ohms. If the impedance of the receiver under test differs from 75 ohms the input signal voltages shall be adjusted on the following basis:—

$$V^1 = V\sqrt{R^1/75}$$

where V^1 is the modified input voltage.
V is the input voltage for 75 ohms impedance.
R^1 is the actual input impedance.

5.2 *Selectivity (Including De-sensitization)*

Method of Test. The selectivity shall be measured by a two-signal method in which two Signal Generators, "A" and "B", are connected through a standard input network according to Clause 2.8.2 above, to the input of the receiver, which shall be operated with temperature and supply voltage conditions as indicated in the Table below.

For the tests at low temperature, the temperature measured at a point not more than one inch from the receiver case shall be maintained at −10° C for at least one hour with the equipment switched off. The equipment shall then be switched on for 30 minutes after which the tests shall be made immediately.

For the tests at high temperature, the temperature measured at a point not more than one inch from the receiver case shall be maintained at +40° C for at least one hour, with the equipment switched on; the tests shall be made at the end of this period.

With Signal Generator " B " switched off, in a manner which does not alter its output resistance, a standard test signal according to Clause 2.7 above, shall be applied to the receiver from Signal Generator " A " at the nominal tune frequency of the receiver and at the level required to produce a signal-to-noise ratio of 10 db measured in the frequency band 300–3000 c/s at the receiver output. Signal Generator " B " shall then be switched on, modulated with 1500 c/s to produce a deviation of ±2·5 kc/s and set alternately to frequencies above and below the frequency of Signal Generator " A " by the amounts listed in the Table below. In each case the level of the test signal from Signal Generator " B " shall be adjusted until the signal-to-noise plus interference ratio at the receiver output falls by 3 db below the value obtained with Signal Generator " A " alone.

The tests shall be repeated with Signal Generator " B " amplitude modulated to a depth of 50 per cent by a sinusoidal tone of frequency 1500 c/s. (The total harmonic distortion of this test modulation shall not exceed 2 per cent.)

Receiver Test Condition		Frequency Separation between Signal Generators " A " and " B " (kc/s)	
Temperature °C	Supply Voltage. Per cent difference from standard test voltage	Base Station Receiver	Mobile Station Receiver
Standard Test	−10	22·0	23·5
Standard Test	+10	22·0	23·5
−10	−10	22·0	23·5
−10	+10	22·0	23·5
+40	−10	22·0	23·5
+40	+10	22·0	23·5

Minimum Standard. When the signal voltage ratio of Signal Generator " B " to Signal Generator " A " is not less than 70 db at standard test temperature, according to Clause 2.3 above, or 60 db at the other temperatures shown in the Table above:—

(*a*) the signal-to-noise plus interference ratio at the output of the receiver shall be not less than 7 db, and

(*b*) the power at the output of the receiver when modulated test signals from both Signal Generator " A " and Signal Generator " B " are applied to its input shall not fall by more than 3 db below that when Signal Generator " B " is switched off.

5.3 *Sensitivity*

Method of Test. The standard test signal according to Clause 2.7 above shall be applied at the tune frequency of the receiver through the standard input network according to Clause 2.8.1 above, at a level of 5 microvolts. The receiver shall then be adjusted for standard power output according to Clause 2.9 above. Under the same conditions, with the modulation switched off, the residual power output in the frequency band 300–3000 c/s shall be measured.

Minimum Standard. The signal-to-noise ratio measured as the ratio of standard power output according to Clause 2.9 above to the residual power output shall be not less than 10 db.

5.4 *Blocking*

Method of Test. Two Signal Generators, " A " and " B ", shall be connected to the input of the receiver through a standard input network according to Clause 2.8.2 above. With Signal Generator " B " switched off in a manner which does not alter its output impedance, a

standard test signal, according to Clause 2.7 above, at the tune frequency of the receiver shall be applied to the receiver input from Signal Generator " A ", at the level required to produce a signal-to-noise ratio of 10 db. The receiver shall be adjusted to give the standard output power according to Clause 2.9 above. An unmodulated signal from Signal Generator " B " at a level of 100 millivolts at its output and at various frequencies shall be applied to the input of the receiver simultaneously with the signal from Signal Generator " A ". The AGC shall be allowed to function normally.

Minimum Standard. The signal from Signal Generator " B " at any frequency (other than spurious response frequencies) removed from the frequency of Signal Generator " A " by 150 kc/s or more shall not cause the output power of the receiver to change by more than 3 db.

5.5 *Cross-modulation*

Method of Test. Two Signal Generators, "A" and " B", shall be connected through a standard input network according to Clause 2.8.2 above, to the input of the receiver. With Signal Generator " B " switched off in a manner which does not alter its output impedance, a standard test signal, according to Clause 2.7 above at a level of three millivolts at the output of Signal Generator " A " shall be applied to the receiver which shall be adjusted to give standard output power, according to Clause 2.9 above. The modulation shall then be switched off and a standard test signal, according to Clause 2.7 above, from Signal Generator " B " at a level of 100 millivolts at its output and at various frequencies shall also be applied to the receiver. The AGC shall be allowed to function normally.

Minimum Standard. The simultaneous application of the prescribed unmodulated signal from Signal Generator

" A " and the standard test signal, according to Clause 2.7 above, from Signal Generator " B " at any frequency (other than spurious response frequencies) removed from the tune frequency by 150 kc/s or more shall not result in an output power greater than —20 db relative to the standard output power according to Clause 2.9 above.

5.6 *Spurious Responses*

Method of Test. A standard test signal according to Clause 2.7 above at the tune frequency of the receiver shall be applied through the standard input network according to Clause 2.8.1 above at the level at which a 10 db signal-to-noise ratio is obtained and the receiver shall be adjusted for standard power output according to Clause 2.9 above. The input level shall then be increased by 70 db and the signal-to-noise ratio measured with various test signal frequencies. The AGC shall be allowed to function normally during this test.

Minimum Standard. At frequencies removed from the tune frequency by more than 25 kc/s, the signal-to-noise ratio at the output of the receiver shall be less than 10 db.

5.7 *Intermodulation*

Method of Test. Three Signal Generators " A ", " B " and " C " shall be connected through a standard input network according to Clause 2.8.2 above to the input of the receiver. A standard test signal, according to Clause 2.7 above, shall be applied to the receiver from Signal Generator " A " alone at the tune frequency of the receiver and at the level required to produce a signal-to-noise ratio of 10 db at the output of the receiver.

Signal Generator " B " shall then be used to apply an unmodulated signal at a frequency of 25 kc/s above (or below) the tune frequency of the receiver; at the same time a test signal according to Clause 2.7 above, but modulated

at 400 c/s to produce a frequency deviation of ±2·5 kc/s, shall be applied to the receiver from Signal Generator " C " at a frequency 50 kc/s above (or below) the tune frequency of the receiver. The output of Signal Generators " B " and " C " shall be at an equal level which shall be increased until the signal-to-noise ratio resulting from Signal Generator " A " is reduced to 7 db. The frequency of Signal Generator " B " shall be adjusted slightly for the purpose of this test to produce maximum interference, due to intermodulation products, including any beat note that may be present.

The ratio of the output voltage of Signal Generator " B " (or Signal Generator " C ") to that of Signal Generator " A " measures the intermodulation response.

The test shall be repeated with Signal Generator " A " set to produce the signal levels shown in the minimum standard table below:—

Minimum Standard

Output of Signal Generator " A " (db relative to the output at which a 10 db signal-to-noise ratio is obtained)	Output Voltage ratio of Signal Generator " B " (or " C ") to Signal Generator " A " (db)
Zero	+50
+20	+40
+40	+30

5.8 *Spurious Emissions*

5.8.1 *Spurious Signal Power at Aerial Terminals*

Method of Test. The aerial terminals shall be closed with a resistance equal to the source impedance from which the receiver is designed to work. A suitable test

receiver and a standard signal generator shall be used to evaluate the spurious signal voltages appearing across the terminating resistance at various frequencies.

Minimum Standard. The maximum power measured in the terminating resistance shall not exceed 20 milli-microwatts at any frequency.

5.8.2 *Spurious Radiation.* The emission of spurious frequencies by direct radiation from components and wiring of receivers shall be minimized, and the Manufacturer shall be responsible for ensuring that interference is not suffered by other radio users.

In the event of interference being traced to the radiation of spurious frequencies, the Manufacturer shall be required to suppress the interference to a degree which shall be satisfactory to the Postmaster General.

6. Postmaster General's Discretion

The Postmaster General shall have the power to waive or relax the requirements of this Specification in any particular.

(26697) Wt.2180 K4 8/60 C.P.Ltd. 999

KUNGL. TELESTYRELSEN, STOCKHOLM, SWEDEN

TECHNICAL SPECIFICATIONS FOR LANDMOBILE EQUIPMENT FOR 25 KC CHANNEL SPACING IN THE 80 MC BAND

(Abbreviated Translation)

TRANSMITTER

Frequency tolerance: ±0.001% for fixed stations.
±0.002% for mobile stations.
Within -25° C to +40°C and
-15% to +10% of nominal supply voltage.
Before measuring the frequency at -25°C
the equipment should warm-up 5 minutes in
standby condition.

Modulation: Frequency modulation (tonesignalling allowed).
Modulation frequency max. 2.6 kc/s.

Frequency swing: Max. ±5 kc/s.
Modulation limiter with low-pass filter.
In the frequency range 2.6 to 12.5 kc/s the
filter must attenuate the modulation at least
40 x log (f/2.5) where f is the frequency in
kc/s with reference to the level at 1 kc/s.
At frequencies above 12.5 kc/s the attenuation
must be at least 28 dB in relation to the level
at 1 kc/s.

Output power: Max. 100 watt effective radiated power.

Antenna height: Max. 50 metres.

Spurious radiation: Harmonics max. 20 µW, or at least 40 dB below
carrier. Other spurious max. 0.2 µW or at least
60 dB below carrier.

RECEIVER

Frequency tolerance: As for transmitter.

Selectivity: Min. 80 dB at adjacent channel. Method of measure-
ment according to "EIA STANDARD RS-204", point 7.2.

Intermodulation: At least attenuated 70 dB. Method of measurement
according to "EIA STANDARD RS-204", Point 9.2.

Spurious response: At least 70 dB.

Spurious radiation: Max. 0.01 µW.

RETMA STANDARD

Minimum Standards for
Land-Mobile Communication
FM or PM Transmitters
25-470 MC

RS-152

April 1956

Engineering Department

RADIO-ELECTRONICS-TELEVISION MANUFACTURERS ASSOCIATION

Storno

NOTICE

EIA standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist the purchaser in selecting and obtaining without delay the proper product for its particular need. Existence of such standards does not in any respect preclude any member or non-member of EIA from manufacturing or selling products not conforming to the standard.

Any proposal of recommended standards and practices made by the Association is without any regard to whether or not their adoption may in any way involve patents on articles, materials or processes. By such action, the Association does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the recommended standards or practices.

Published by

ELECTRONIC INDUSTRIES ASSOCIATION

Engineering Department

11 WEST 42nd STREET, NEW YORK 36, N. Y.

ATELIER ELEKTRA
KØBENHAVN

MINIMUM STANDARDS FOR LAND-MOBILE COMMUNICATION – FM OR PM TRANSMITTERS, 25-470 MC

(From Standards Proposal No. 466)

1. STANDARD TEST CONDITIONS

1.1 Definition — Standard test conditions are those conditions which shall apply to a transmitter while it is being tested for minimum requirements. These conditions apply unless otherwise specified.

1.2 Specific Standard Test Conditions

1.2.1 Standard Test Voltage shall be that voltage specified in 10.

1.2.2 Standard Temperature and Humidity shall be as follows:

Temperature range 20° C to 35°C:

20°C to 30°C, zero to 90 percent humidity

30°C to 35°C, zero to 70 percent humidity

1.2.3 Standard Test Modulation shall be 1000 cycles per second at such a level to produce two-thirds of full rated system deviation.

1.2.4 Standard Output Load shall consist of a resistive termination equal to the load into which the transmitter normally operates.

1.2.5 Standard Loading Conditions for the RF output circuits shall be those specified by the manufacturer in the literature normally furnished with the transmitter.

1.2.6 Standard Test Receiver. The standard test receiver audio response characteristic shall not deviate more than ±1 db from a 750 usec deemphasis curve between 50 and 3000 cps.

1.2.7 Modulation Limiting. The modulation limiting shall be operative for all tests as in 8, except as otherwise specified.

1.2.8 Associated Equipment. The standard associated equipment to be used with the transmitter during these tests is that with which it normally operates. In mobile equipment, this means the receiver and proper power supply will be included and operating in the case. In base equipment, this means that the correct power supply and other chassis that will affect operation are included and operating in the cabinet supplied.

2. CARRIER POWER OUTPUT RATING

2.1 Definition — The carrier power output rating of a transmitter for this service is the power available at the output terminals of the transmitter when the output terminals are connected to the normal load circuit or to a circuit equivalent thereto under the conditions given in 2.3.

2.2 Minimum Standard — The manufacturer's rating of carrier output shall not be higher than that obtained under the conditions given in 2.3. No recommendations as to standardized power output levels are made.

2.3 Method of Measurement

2.3.1 Transmitter carrier power output ratings may be designated as either continuous or intermittent according to the following test conditions:

(a) *Continuous* — the full load output under the manufacturer's normal recommended loading conditions for this class of service for 24 hours without dropping below rated power output.

(b) *Intermittent* — full load output under normal recommended loading conditions for this class of service, using a cycle of one minute on and four minutes off for a period of eight hours followed by three continuous test cycles of five minutes on, fifteen minutes off.

2.3.2 Transmitter power output may be measured by calorimetric, lossy line and voltmeter, or rf wattmeter methods with the transmitter terminated in its normal load impedance. The basic accuracy of the method used shall be at least 10%.

3. SPURIOUS RADIATIONS

3.1 Definition — Spurious radiations are any radio-frequency emissions except harmonics of the output carrier frequency which are radiated by or from the transmitter other than its specified carrier frequency and modulation products. Spurious radiations also include those parasitic oscillations which may result when drive is removed.

3.2 Minimum Standard — Spurious radiations shall be attenuated below the maximum level of emission at the carrier frequency in accordance with the following table:

Plate Power Input to the Final Radio Stage	*Attenuation DB*
3 Watts or less	40
Over 3 Watts up to and including 25 Watts	60
Over 25 Watts up to and including 150 Watts	60
Over 150 Watts up to and including 600 Watts	70
Over 600 Watts	80

3.3 Method of Measurement — The level of the carrier frequency and the various spurious radiated frequencies shall be measured by means of a calibrated receiving system used to compare the output of the transmitter with that of a standard signal generator at the spurious frequency.

4. HARMONIC RADIATIONS

4.1 Definition — Harmonic radiations are radio-frequency emissions radiated by or from the transmitter on multiples of its specified carrier frequency.

4.2 Minimum Standard — Harmonic radiations shall be attenuated below the maximum level of emissions at the carrier frequency in accordance with the following table:

Plate Power Input to the Final Radio Stage	*Attenuation DB*
3 Watts or less	40
Over 3 Watts up to and including 25 Watts	60
Over 25 Watts up to and including 150 Watts	60
Over 150 Watts up to and including 600 Watts	70
Over 600 Watts	80

4.3 Method of Measurement — Harmonic radiations may be measured by the method indicated in 3.3.

5. AUDIO FREQUENCY HARMONIC DISTORTION

5.1 Definition — The audio frequency harmonic distortion is the change in harmonic content of the input signal as a result of passing through the audio and rf circuits of the transmitter.

5.2 Maximum Standard — The distortion shall not exceed 10% at standard test conditions.

5.3 Method of Measurement — The transmitter will be adjusted per the manufacturer's procedures and instruction for full rated system deviation. A sine wave of less than 1% distortion at 1000 cps will be applied at such level to produce two-thirds of full rated system deviation. The standard test receiver will be tuned to the carrier frequency and the distortion in the receiver output measured. The calibration of the equipment used to measure frequency swing should be maintained by the Bessel-Null method.

6. AUDIO FREQUENCY RESPONSE

6.1 Definition — The term "audio frequency response" denotes the degree of closeness to which the frequency deviation of the transmitter follows a 6 db per octave pre-emphasis characteristic with constant amplitude audio frequency input over a continuous frequency range.

6.2 Maximum Standard — The audio frequency response shall not vary more than +1 or −3 db from a true 6 db pre-emphasis characteristic from 300 to 3000 cps as referred to the 1000 cycle level.

6.3 Method of Measurement — Operate the transmitter under standard test conditions and monitor the output with a frequency deviation meter or a calibrated test receiver. With a 1000 cps sine wave audio input applied through a dummy microphone circuit, adjust the audio input to give 30% of full rated system deviation. Keep the audio input level constant, vary the modulating frequency from 300 to 3000 cps and observe the frequency deviations. Modulation limiters must be active and set per manufacturer's instructions during this test.

7. F.M. HUM AND NOISE LEVEL

7.1 Definition — The term "F.M. Hum and Noise Level" denotes the ratio of residual frequency modulation to standard test modulation measured on the standard test receiver.

7.2 Minimum Standard — The F.M. Hum and Noise Level for both land and mobile transmitters shall be 40 db below standard test modulation where full rated system deviation is 15 KC. (When full rated system deviation is less than 15 KC, the F.M. Hum and Noise Level ratio may be proportionately reduced.)

7.3 Method of Measurement — With the transmitter operating under standard test conditions, monitor the output with the standard test receiver. Read the output level, remove modulation from the transmitter and record the change in output level of the test receiver.

8. MODULATION LIMITING

8.1 Definition — Modulation limiting refers to the ability of the transmitter circuits to prevent the transmitter from producing deviations due to modulation in excess of a rated system deviation.

8.2 Minimum Standard — The transmitter modulation must not exceed rated system deviation at any audio frequency input level from the two-thirds rated input level to a value 20 db greater.

8.3 Method of Measurement — The transmitter shall be adjusted for full rated system deviation. Adjust the audio input for two-thirds of rated system deviation at 1000 cps. Increase the level 20 db and measure the deviation for all frequencies between 300 and 3000 cps. The deviation may be measured as specified in 5.3.

9. CARRIER FREQUENCY STABILITY

9.1 Definition — The carrier frequency stability is the ability of the transmitter to maintain an assigned carrier frequency. The carrier frequency stability is expressed as the maximum percentage of the assigned frequency that the center-frequency will deviate from that frequency in the absence of modulation and within the limits of the test conditions given below.

9.2 Minimum Standard — The minimum carrier frequency stability shall be:

(a) ±0.003% in systems below ±10 Kc rated system deviation.

(b) ±0.005% in system at and above ±10 Kc rated system deviation.

9.3 Method of Measurement — The frequency of the transmitter shall be measured by extracting a sample of carrier and measuring its center frequency by equipment having a degree of accuracy of at least twice the stability of the minimum to be measured.

10. POWER SUPPLY TEST VOLTAGE

10.1 Definition — Power supply test voltage is the primary voltage applied to the equipment.

10.2 Standard Test Voltage — The standard test voltages shall be as follows:

Nominal Power Supply Voltage	*Test Voltage*
6 VDC	See Note 1
12 VDC	See Note 1
24 VDC	26.4V
32 VDC	36.0V
64 VDC	72.0V
110 VDC	110.0V
110/120 VAC	117.0V

NOTE 1: The standard test voltage for equipments having a nominal power supply of 6 or 12 volts shall be determined from the operating current for which the equipment is designed and referenced to the following table:

Nominal 6 Volt Power Supply

Operating Current	*Test Voltage*
2A	6.6V
15A	6.5V
40A	6.3V
60A	6.2V
80A	6.1V

Nominal 12 Volt Power Supply

Operating Current	*Test Voltage*
2A	13.8V
15A	13.6V
27A	13.4V
40A	13.2V

10.3 Method of Measurement

10.3.1 ***Mobile Equipment.*** The primary power voltage shall be measured at the battery terminals with the grounded terminal of the battery connected to the equipment chassis by seven feet of #6 conductor. The cables normally supplied with the equipment should be connected in the usual manner specified by the manufacturer.

10.3.2 ***Base Equipment.*** The primary power voltage shall be measured at the input terminals to the equipment.

11. POWER SUPPLY VOLTAGE RANGE

11.1 Definition — The power supply voltage range is the range of primary voltage over which the transmitter will operate with a specified performance.

11.2 Minimum Standard — Over a voltage range equal to the standard test voltage plus and minus 10%, the power output shall not drop more than 3 db below the power output at the standard test voltage. All other transmitter requirements shall be met.

Over a voltage range equal to the standard test voltage minus 20%, the equipment shall start and the power output shall not drop more than 10 db. Above the voltage range of the standard test voltage plus 10%, the life of components may be reduced and therefore operation from +10% to +20% cannot be guaranteed.

11.3 Method of Measurement

11.3.1 ***Mobile Equipment.*** The primary power voltage shall be measured at the battery terminals with the grounded terminals of the battery connected to the equipment chassis by seven feet of #6 conductor. The cables normally supplied with the equipment should be connected in the usual manner specified by the manufacturer. Individual performance characteristics shall be measured as outlined in previous paragraphs.

11.3.2 ***Base Equipment.*** The primary power voltage shall be measured at the input terminals to the equipment.

12. TEMPERATURE RANGE

12.1 Definition — The term "temperature range" refers to the range of ambient temperature over which a transmitter will operate with no more than a specified amount of degradation in overall performance.

12.2 Minimum Standard — For the range of ambient temperatures between −30°C and +60°C, the following transmitter characteristics shall not deteriorate by more than the specified amount.

12.2.1 Power output shall not be more than 3 db below the output obtained under standard test conditions.

12.2.2 The hum and noise level shall not be degraded more than 6 db below the level specified in 7.2.

12.3 Method of Measurement — The method of measurement at any specific temperature shall be as follows: The equipment installed in the case normally supplied shall be operated according to the duty cycle specified in 2.3 in a box or room the temperature of which shall be maintained at the specific temperature without forced circulation of air over the equipment for a period of at least five hours. Performance of the equipment shall then be evaluated.

13. HIGH HUMIDITY

13.1 Definition — The term "high humidity" denotes the relative humidity at which a transmitter will operate with no more than a specified amount of degradation in overall performance.

13.2 Minimum Standard — Under the test conditions given in 13.3, the overall performance of the transmitter shall not fall below the following limits:

13.2.1 Power output shall not be more than 3 db below the output obtained under standard test conditions.

13.2.2 The hum and noise level shall not be degraded more than 6 db below the level specified in 7.2.

13.3 Method of Measurement — The transmitter, after having been adjusted for normal operation under standard test conditions, shall be placed, inoperative, in a humidity chamber. The relative humidity shall be maintained as at least 90% at 50°C for a period of not less than 8 hours. After removal from the humidity chamber, excess moisture may be blown off with an air hose. The transmitter shall be tested for power output, hum and noise level, and carrier-frequency stability within 15 minutes after its removal from the humidity chamber, as specified in 2., 7. and 9. No readjustment of the transmitter shall be allowed during the test.

14. VIBRATION STABILITY

14.1 Definition — Vibration stability is the ability of the equipment to maintain specified mechanical and electrical performance during and after being vibrated.

14.2 Minimum Standard — No fixed part shall become loose or movable part shifted in position or adjustment under either of the two conditions of vibration. The hum and noise level shall not be degraded more than 10 db below the level specified in 7.2. This specification not applicable to fixed or base station equipment.

14.3 Method of Measurement — The equipment shall meet all electrical requirements while being vibrated with simple harmonic motion having an amplitude of 0.015″ (total excursion of 0.030″) with the frequency varied uniformly between 10 and 30 cycles per second, and an amplitude of 0.0075″ (total excursion of 0.015″) with the frequency varied uniformly from 30 to 60 cycles per second. The entire cycle of frequencies for each group, i.e. 10 to 30 cps and 30 to 60 cps, shall be accomplished in five minutes and repeated three times. The above motion shall be applied for a total period of 30 minutes in each of three directions. Namely, the directions parallel to both axes of the base, and perpendicular to the plane of the base.

15. SHOCK STABILITY

15.1 Definition — Shock stability is the ability of the equipment to maintain specified mechanical and electrical performance after being shocked.

15.2 Minimum Standard — The equipment shall meet all electrical requirements and suffer no mechanical damage after being subjected to a series of not less than ten impacts in each plane (total thirty). Each impact shall be not less than 20g acceleration. This specification is not applicable to fixed or base station equipment.

15.3 Method of Measurement — Acceleration shall be applied to the manufacturer's mounting facilities, and may be measured by means of a suitable accelerometer. The equipment shall be operated under standard test conditions, and during one-half the impacts in each plane, the transmitter shall be operative.

16. AM HUM AND NOISE

16.1 Definition — The AM hum and noise level on the carrier is the ratio of the peak AC voltage to the DC voltage detected from the carrier.

16.2 Minimum Standard — The AM hum and noise level shall not exceed —34 db.

16.3 Method of Measurement — Measurement of the AM hum and noise level may be accomplished by the use of a linear peak-carrier responsive AM detector coupled to the output of the transmitter. Readings are made of the DC voltage and the peak value of the AC component across the detector load resistor. Those measurements shall be made in the absence of modulating voltage. The audio input terminal of the transmitter shall be shunted by a resistance equal to the transmitter input impedance.

17. SIDE BAND NOISE LEVEL

17.1 Definition — The term "side band noise level" denotes the ratio of residual noise, at a discreet frequency separation from the carrier, to the level of the unmodulated carrier, expressed in db.

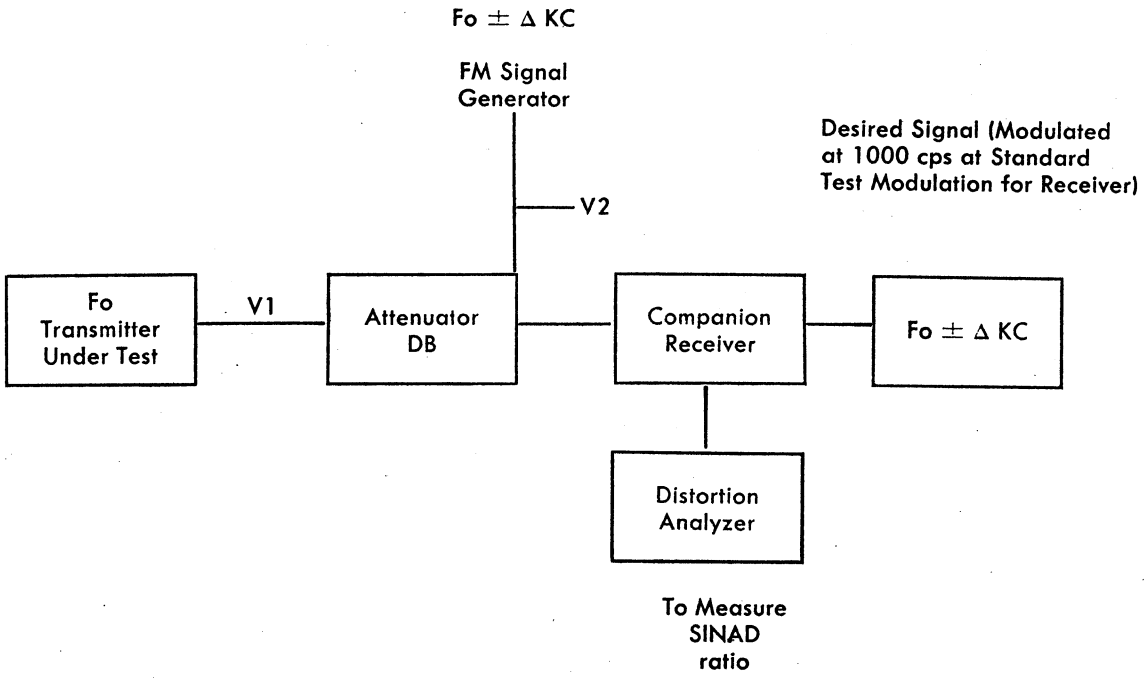
17.2 Minimum Standard — The side band noise level in the absence of modulation shall be measured at the center of the adjacent channel and shall be below the level of the unmodulated carrier by at least the following:

Plate Power Input to the Final Radio Stage	*DB Attenuation Side Band Noise*
3 Watts or less	46
Over 3 Watts up to and including 25 Watts	56
Over 25 Watts up to and including 150 Watts	66
Over 150 Watts up to and including 600 Watts	76
Over 600 Watts	86

17.3 Method of Measurement — The method of measuring side band noise level is very similar to measuring receiver selectivity by the two-signal selectivity method. It is designed to place a db figure on the adjacent channel performance of a transmitter as well as a means of evaluating the side band noise level in terms of the band width of a receiver which would normally be used in an

adjacent channel. Referring to the diagram, a companion receiver is tuned to the adjacent channel of an unmodulated transmitter. With the transmitter turned off, a desired signal, as shown, is adjusted to give a 12 db SINAD ratio. (Note: SINAD = S+N+D/N+D). The transmitter is then turned on and the attenuator is adjusted to give a 6 db SINAD ratio. The noise level of the transmitter is then calculated as follows:

$$\text{Noise level} = 20 \log \frac{(V1)}{(V2)} - \text{db of the attenuator.}$$



Δ KC = Frequency Separation Between Adjacent Channels

EIA STANDARD

Minimum Standards for Land-Mobile Communication FM or PM Receivers

RS-204
(Revision TR-119-A)

January 1958

Engineering Department

ELECTRONIC INDUSTRIES ASSOCIATION

(formerly RADIO-ELECTRONICS-TELEVISION MANUFACTURERS ASSOCIATION)

Storno

NOTICE

RETMA standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist the purchaser in selecting and obtaining without delay the proper product for its particular need. Existence of such standards does not in any respect preclude any member or non-member of RETMA from manufacturing or selling products not conforming to the standard.

Any proposal of recommended standards and practices made by the Association is without any regard to whether or not their adoption may in any way involve patents on articles, materials or processes. By such action, the Association does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the recommended standards or practices.

Published by

RADIO-ELECTRONICS-TELEVISION MANUFACTURERS ASSOCIATION

Engineering Department

11 WEST 42nd STREET, NEW YORK 36, N. Y.

MINIMUM STANDARDS FOR LAND - MOBILE COMMUNICATION FM OR PM RECEIVERS

(From Standard TR-119-A and Standards Proposal No. 561, formulated under the cognizance of the EIA Engineering Committee TR-8 on Land-Mobile Services)

1. STANDARD TEST CONDITIONS

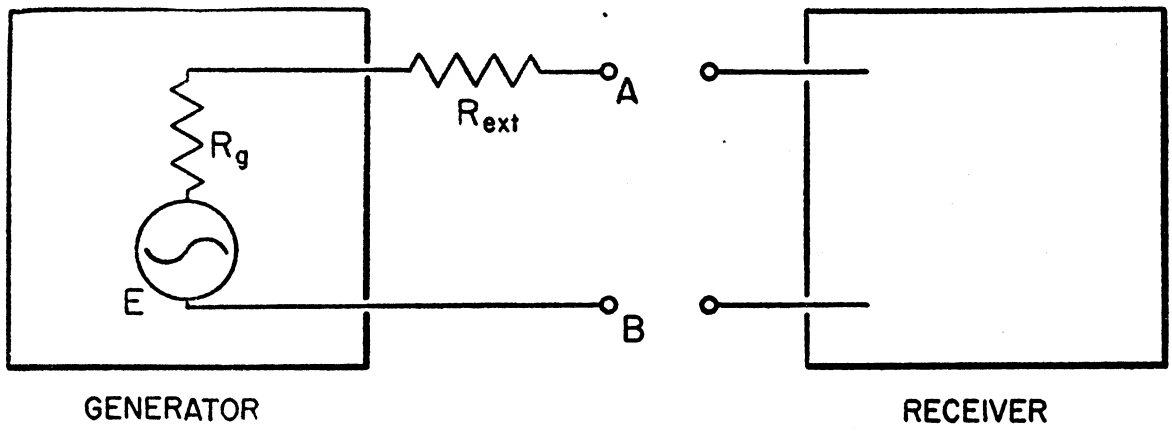
1.1 Definition

Standard test conditions are those conditions which shall apply to a receiver while it is being tested for minimum requirements. These conditions apply unless otherwise specified.

1.2 Specific Standard Test Conditions

1.2.1 *Standard Input Signal Source*

A standard input signal source is a calibrated signal generator whose internal plus external resistance is 50 ohms, the voltage to be measured across terminals A and B when A and B are *open circuited.*



$$R_g + R_{ext} = 50\,\Omega$$

For all tests, except where otherwise specified, the frequency of the generator shall be adjusted to the center frequency of the channel on which the receiver is intended to operate.

1.2.2 *Standard Test Modulation*

The standard test modulation shall be ± ⅔ of *maximum* rated system deviation at 1000 c.p.s.

Frequency Range	*Maximum Rated System Deviation*	*Channel Spacing*
25-54 MC.	±15 KC.	40 KC.
25-54 MC.	± 5 KC.	20 KC.
144-174 MC.	±15 KC.	60 KC.
144-174 MC.	± 5 KC.	30 KC.
400-470 MC.	±15 KC.	100 KC.
400-470 MC.	±10 KC.	50 KC.

1.2.3 *Standard Output Load*

The standard output load shall consist of an output indicator which is connected to the final audio power amplifier of a receiver. This load shall present a resistive load equal to the load into which the receiver normally operates.

1.2.4 *Standard Temperature*

Standard temperature shall be +20° to +35° C.

1.2.5 *Standard Relative Humidity*

Standard relative humidity shall be

zero to 90 percent at 20°C to 30°C
zero to 70 percent at 30°C to 35°C

1.2.6 ***Standard Squelch Conditions***
The receiver squelch control shall be unsquelched to its maximum extent unless otherwise specified.

1.2.7 ***Associated Equipment***
The standard associated equipment to be used with the receiver during these tests is the associated equipment with which it normally operates. In mobile equipment, this means the transmitter and proper power supply will be included and operating in the housing. During high temperature environmental tests, 16.2.2, the transmitter shall be cycled in accordance with the appropriate duty cycle. In land station equipment, this means that the correct power supply and other chassis that will affect operation are included and operating in the cabinet supplied.

2. POWER SUPPLY TEST VOLTAGE

2.1 Definition
Power supply test voltage is the primary voltage applied to the input of the power cable normally supplied with the receiver during all tests unless otherwise specified.

2.2 Standard Test Voltage
The standard test voltages shall be as follows:

Nominal Power Supply Voltage	*Test Voltage*
6 VDC	See Note 1
12 VDC	See Note 1
24 VDC	26.4 Volts
32 VDC	36.0 Volts
64 VDC	72.0 Volts
110 VDC	110.0 Volts
110/120	117.0 Volts

Note 1: *The standard test voltage for equipments having a nominal power supply of 6 or 12 volts shall be determined from the operating current for which the equipment is designed and referenced to the following table:*

Nominal 6 Volt Power Supply

Operating Current	*Test Voltage*
Below 10A	6.6 Volts
10A to 22A	6.5 Volts
22A to 36A	6.4 Volts

Nominal 12 Volt Power Supply

Operating Current	*Test Voltage*
Below 6A	13.8 Volts
6A to 16A	13.6 Volts

2.3 Method of Measurement
2.3.1 ***Mobile Equipment***
The primary power voltage shall be measured at the battery terminals with the grounded terminal of the battery connected to the equipment chassis by seven feet of #6 conductor. The cables normally supplied with the equipment shall be connected in the manner specified by the manufacturer.

2.3.2 ***Base Equipment***
The primary power voltage shall be measured at the input terminals to the equipment.

3. USABLE SENSITIVITY

3.1 Definition
The usable sensitivity of a receiver is the minimum value of the standard test input signal from a standard input signal source which, when modulated at standard test modulation, will produce at least 50% of the receiver's rated audio power output with 12db signal + noise + distortion to noise + distortion ratio. The receiver is to be tested under standard test conditions.

3.2 Method of Measurement

A 1000 microvolt test signal from a standard input signal source with standard test modulation shall be connected to the receiver antenna input terminals. A standard output load and a distortion meter incorporating a 1000 cycle band elimination filter shall be connected to the receiver audio output terminals. The receiver volume control shall be adjusted to give rated audio output. The standard input signal source attenuator shall be adjusted until the ratio of signal + noise + distortion to noise + distortion is 12 db. At this value of signal input, it shall be possible to obtain at least 50% of the rated audio output without re-adjustment of the volume control. If it is not possible to obtain this amount of audio output, the RF signal input shall be increased until 50% of full rated audio output is obtained, and this value of RF signal input shall be used in specifying sensitivity.

3.3 Minimum Standard

The minimum usable sensitivity shall be as follows:

Band	*Microvolts (Open Circuit)*
25-54 MC.	1.0
144-174 MC.	1.5
400-470 MC.	2.5

Note: *Open circuit voltage is twice the voltage available across the receiver antenna input terminals if the receiver antenna input impedance is 50 ohms.*

4. QUIETING SENSITIVITY (Applies only to receivers using one or more limiters and a discriminator)

4.1 Definition

The quieting sensitivity of a receiver is the minimum amount of signal from an unmodulated Standard Input Signal Source that is required to produce 20 decibels of noise quieting measured at the receiver audio output.

4.2 Method of Measurement

An unmodulated Standard Input Signal Source shall be connected to the receiver under test. The receiver under test shall be operated under Standard Test Conditions. A standard output load shall be connected to the receiver audio output terminals and the noise level shall be adjusted to 25 percent of rated output using the receiver volume control. The attenuator of the signal generator shall be adjusted for the minimum amount of signal required to produce 20 decibels of noise quieting.

4.3 Minimum Standard

The minimum quieting sensitivity shall be as follows:

Band	*Microvolts (Open Circuit)*
25-54 MC.	1.0
144-174 MC.	1.5
400-470 MC.	2.5

Note: *Open circuit voltage is twice the voltage available across the receiver antenna input terminals if the receiver antenna input impedance is 50 ohms.*

5. AUDIO SQUELCH SENSITIVITY

5.1 Definition

The audio squelch sensitivity of a receiver is the minimum value of the standard test input signal source, which, when modulated at standard test modulation, will open the receiver squelch.

5.2 Method of Measurement

5.2.1 *Threshold Squelch*

A standard input signal source shall be connected to the receiver and a standard output load shall be connected to the audio output terminals of the receiver. With no RF signal input to the receiver, the squelch control shall be adjusted to reduce the audio output at least 40 db over a ±10 percent power supply voltage range. With the power supply voltage adjusted for standard

test conditions, the RF level of the signal generator attenuator shall be adjusted until the receiver produces continuous audio output. The minimum input signal required to produce this condition is defined as the squelch threshold sensitivity.

5.2.2 ***Tight Squelch***

After measuring the threshold audio squelch sensitivity, the receiver shall be measured for tight audio squelch sensitivity. Where the squelch control is on the control head (or similar location) it shall not be possible to lock out the audio on a strong signal, with the squelch control adjusted to any position. The RF signal required to produce continuous audio output with the squelch control at its tightest position is defined as the tight audio squelch sensitivity. In the case of equipment, where the control is concealed (such as a chassis adjustment) it will not be necessary to prevent lockout. However, it must be possible to adjust the squelch for normal operation over the range specified by the manufacturer.

5.3 Minimum Standard

The threshold audio squelch sensitivity shall be as follows:

Frequency Range	*Microvolts (Open Circuit)*
25 to 54 MC.	0.5 Max.
144 to 174 MC.	0.75 Max.
400 to 470 MC.	1.25 Max.

Note: *Open circuit voltage is twice the voltage available across the receiver antenna input terminals if the receiver antenna input impedance is 50 ohms.*

6. MODLUATION ACCEPTANCE BANDWIDTH

6.1 Definition

The moduation acceptance bandwidth of a receiver is a measure of the deviation that the receiver will accept at an RF signal level 6 db above the measured usable sensitivity.

6.2 Method of Measurement

A standard input signal source shall be connected to the receiver. The signal generator frequency shall be adjusted to the resonant frequency of the receiver and the deviation shall be adjusted for standard test modulation. A standard output load and a distortion meter incorporating a 1000 cycle band elimination filter shall be connected to the receiver output terminals. The receiver volume control shall be adjusted for rated power output with a 1000 microvolt signal. Then the standard signal source attenuator shall be adjusted until the ratio of signal + noise + distortion to noise + distortion is 12 db. The RF input signal from the standard signal source shall be increased +6 db and the deviation shall be increased until the ratio of signal + noise + distortion to noise + distortion is again 12 db.

6.3 Minimum Standard

The minimum modulation acceptance bandwidth shall be not less than the rated system deviation for which the receiver is intended.

7. ADJACENT CHANNEL SELECTIVITY AND DENSENSITIZATION

7.1 Definition

The adjacent channel selectivity and desensitization of a receiver is a measure of its ability to differentiate between a desired modulated signal and modulated signals which differ in frequency from the desired signal by the width of one channel.

7.2 Method of Measurement

The output of the radio receiver shall be terminated in a standard output load. Two signal generators shall be coupled with a suitable matching network to provide equal on signal input to the receiver antenna input terminals. Signal generator #1 shall be adjusted as outlined in 3.2. Signal generator #2, modulated with ⅔ of maxmium rated system deviation at 400 cps, shall be tuned first to the high and then to the low adjacent channel. Its attenuator shall be adjusted until the 12 db signal + noise + distortion to noise + distortion ratio is decreased to 6 db. The adjacent channel selectivity shall be specified as the ratio, expressed in db, of the amplitude of signal #2

to signal #1. If the ratio for the high side adjacent channel is different from the ratio for the low side adjacent channel, the smaller ratio, expressed in db, shall be used in specifying selectivity.

7.3 Minimum Standard

The minimum adjacent channel selectivity shall be 70 db.

8. SPURIOUS RESPONSE ATTENUATION

8.1 Definition

A receiver's spurious response attenuation is a measure of its ability to discriminate between a desired signal to which it is resonant and an undesired signal at any other frequency to which it is also responsive.

8.2 Method of Measurement

An unmodulated Standard Input Signal Source shall be connected to the receiver under test. The receiver under test shall be operated under Standard Test Conditions. A standard output load shall be connected to the receiver audio output terminals and the noise level shall be adjusted to 25 percent of rated output using the receiver volume control. The attenuator of the signal generator shall be adjusted for the minimum amount of signal required to produce 20 decibels of noise quieting.

The signal generator frequency shall be varied over the continuous frequency range from the lowest radio frequency amplified in the receiver to 1000 MC. and all responses shall be noted (harmonics of the signal generator and frequencies between the adjacent channels shall be excluded). The ratio of the signal generator voltage to produce 20 db of noise quieting at any spurious response frequency to the signal generator voltage required to produce 20 db of noise quieting at resonance, expressed in db, is the receiver's attenuation to the spurious response. The spurious response which requires the least signal input to produce 20 db of noise quieting shall be used to express the receiver's spurious response attenuation.

8.3 Minimum Standard

The spurious response attenuation shall be at least 85 db on all bands for receivers operating below 400 MC. and at least 80 db for receivers operating between 400 and 470 MC.

9. INTERMODULATION SPURIOUS ATTENUATION

9.1 Definition

A receiver's intermodulation spurious response attenuation is the measured amount of its ability to receive a desired signal to which it is resonant in the presence of two interfering signals so separated from the desired signal and from each other that n'th order mixing of the two undesired signals can occur in the non-linear elements of the receiver, producing a third signal whose frequency is equal to that of the desired signal.

9.2 Method of Measurement

The output of the radio receiver shall be terminated in a standard output load. Three signal generators shall be equally coupled to the receiver antenna input terminals through a suitable matching network. Signal generator #1 shall be modulated with standard test modulation. Signal generator #2 shall be unmodulated. Signal generator #3 shall be modulated ⅔ of maximum rated system deviation at 400 cps. With signal generators #2 and #3 turned off, the frequency of signal generator #1 shall be adjusted to the resonant frequency of the receiver, and the output adjusted for equivalent open circuit reference level microvolts input to the receiver (See table 9.3). Generator #2 shall now be adjusted to the adjacent channel above (or below) the signal frequency, and generator #3 shall be adjusted to the alternate channel above (or below) the signal frequency. Generator #3 should be on the same side of the desired frequency as generator #2. The equivalent outputs of generators #2 and #3 shall be maintained at equal levels and these levels shall be increased until the ratio of signal + noise + distortion to noise + distortion is reduced to 6 db.

The frequency of generator #3 shall be adjusted slightly to produce the maximum interfering signal before the final measurement is made. The ratio of the signal from generators #2 and #3 to the signal from the generator #1, expressed in db, is the measure of intermodulation spurious response attenuation.

9.3 Minimum Standard

Desired Open Circuit Signal Reference Level at Receiver Input	*Minimum Requirement*
1. Usable Sensitivity as measured in 3.2	50 db
2. 20 microvolts	40 db
3. 200 microvolts	30 db

10. AUDIO POWER OUTPUT

10.1 Definition

Audio power output denotes the power that the receiver will deliver to a standard load under standard test conditions.

10.2 Method of Measurement

A 1000 microvolt test signal from a standard input signal source with standard test modulation shall be connected to the receiver antenna input terminals. A standard output load and a distortion meter shall be connected to the audio output terminals. The volume control shall be adjusted to give rated power output.

10.3 Minimum Standard

10.3.1 The minimum power output of a receiver normally used to drive a loudspeaker shall be 1.0 watt at no more than 15% distortion.

10.3.2 The minimum power output of a receiver normally used to drive a headphone shall be 50 mw at no more than 10% distortion.

10.3.3 The minimum power output of a receiver normally used to feed a 500-600 ohm line shall be 12 mw at no more than 5% distortion.

10.3.4 The minimum power output of a receiver designed to operate with special devices such as selective signaling apparatus shall be sufficient to insure proper operation of the specific apparatus.

11. AUDIO FREQUENCY RESPONSE

11.1 Definition

Audio frequency response denotes the degree of closeness to which the audio output of a receiver follows a 6 db per octave de-emphasis curve with constant frequency deviation over a given continuous frequency range.

11.2 Method of Measurement

A 1000 microvolt test signal from a standard input signal source with standard test modulation shall be connected to the receiver antenna input terminals. A standard load shall be connected to the audio output terminals. The receiver volume control shall be adjusted for 50% of rated power output.

The modulation shall be reduced to 1/5th of maximum rated system deviation and with the deviation held constant at this value, the modulating frequency shall be varied from 300 to 3000 cycles and the audio frequency output shall be observed.

11.3 Minimum Standard

11.3.1 For receivers that are normally used with loudspeakers the audio response shall not vary more than +2 to −8 db from a standard 6 db per octave de-emphasis curve over the frequency range of 300 to 3000 cps. The reference frequency shall be 1000 cps.

11.3.2 For receivers that are normally used to feed a headphone or a line, the audio response shall not vary more than +1 to −3 db from a standard 6 db per octave de-emphasis curve over the frequency range of 300 to 3000 cps. The reference frequency shall be 1000 cps.

11.3.3 The audio frequency response of receivers designed to operate with special devices, such as selective signaling apparatus, shall be adequate to assure proper operation of the specific apparatus.

12. HUM AND NOISE RATIO

12.1 Definition

Hum and noise ratio denotes the ratio of residual receiver audio output to rated audio output.

12.2 Method of Measurement

12.2.1 *Unsquelched*

The residual hum and noise level shall be measured at the audio output terminals of the receiver when the output is terminated in a standard load, and shall be expressed in db below rated power output. A standard input signal source shall be connected to the antenna terminals of the receiver. With 1000 microvolts input at standard test modulation, the receiver volume control shall be adjusted for rated power output. The modulation shall be turned off and the hum and noise ratio shall be measured as the difference in db between the two output meter readings.

12.2.2 *Squelched*

The signal shall be removed from the receiver antenna input terminals. The receiver squelch shall be adjusted as in 5.2.2, and the volume control setting shall remain as in 12.2.1. The hum and noise ratio for the squelched condition shall be the difference in db between the output meter readings.

12.3 Minimum Standard

The minimum standard for mobile and land receivers shall be as follows:

Unsquelched	40 db
Squelched	50 db

13. POWER SUPPLY VOLTAGE RANGE

13.1 Definition

Power supply voltage range is the range of primary voltage applied to the input end of the primary power cable normally supplied with the receiver, over which the receiver will operate with a specified performance.

13.2 Method of Measurement

The primary voltage shall be measured at the input end of the primary power cable normally supplied with the equipment. A calibrated voltmeter shall be used. The individual performance specifications shall be measured as outlined in previous pertaining paragraphs.

13.3 Minimum Standard

Not more than 3 db degradation in measured audio power output, usable sensitivity and threshold audio squelch sensitivity shall occur when the power source voltage is varied ± 10 percent of the value specified in 2.2, nor shall the tight squelch adjustment lock out a strong signal. The equipment shall start and operate when the source voltage is ± 20 percent of the value specified in 2.2.

14. UNDESIRED CONDUCTED POWER

14.1 Definition

Undesired conducted power is that electro-magnetic energy generated and/or amplified in a receiver and appearing between antenna terminal and ground; or between each terminal that connects to any public utility line and ground.

14.2 Method of Measurement

A calibrated test receiver shall be connected to the receiver side of a suitable line stabilization network (Ref. MIL-I-16910A) and tuned from the lowest radio frequency generated and/or amplified in the receiver to 25 MC. The receiver under test shall be connected as in normal system operation. When testing the voltage appearing across the antenna terminals, the line stabilization network shall be omitted. However, the antenna connection shall be terminated by a resistance equal to its characteristic impedance. The receiver under test shall be tested under conditions of no received signal. The receiver shall also be tested (except for antenna terminal) under conditions of an on channel received signal 60 db above the rated sensitivity.

14.3 Minimum Standard

The limit shall be in accordance with FCC Rules: Part 15, Subpart C, 15.62 as amended.

15. UNDESIRED RADIATED POWER

15.1 Definition

Undesired radiated power is that electro-magnetic energy generated and/or amplified in a receiver and radiated by the antenna and/or all power, control and audio leads normally connected to the receiver.

15.2 Method of Measurement

The method of measurement shall be in accordance with the Institute of Radio Engineers Standard 51IRE 17.S1 (Supplement #2) modified to employ a ¼ wave length vertical whip with ground plane 10 feet above the ground.

15.3 Minimum Standard

The limit shall be in accordance with FCC Rules: Part 15, Subpart C, 15.62 as amended.

16. TEMPERATURE RANGE

16.1 Definition

Temperature range denotes the range of ambient temperature over which a receiver will operate with no more than a specified maximum amount of degradation in overall performance.

16.2 Method of Measurement

16.2.1 After one hour warm-up at standard ambient temperature and humidity, the receiver usable sensitivity (3.2), audio squelch sensitivity (5.2), modulation acceptance bandwidth (6.2), selectivity (7.2), audio power output (10.2) and hum and noise ratio (12.2) shall be noted.

16.2.2 The receiver, installed in the case normally supplied (1.2.7) shall be placed in a box or room the temperature of which can be accurately measured and controlled. It shall remain inoperative for five hours at an ambient temperature of −30°C after which it shall be turned on. The receiver shall start. After a maximum of fifteen minutes of operation it shall be tested according to 16.2.1, without re-adjustment. Tests shall be completed within 1 hour and with the environment maintained at −30°C.

16.2.3 The ambient temperature shall be raised to +60°C and the equipment operated for five hours without forced circulation of air over the equipment. The receiver shall then be tested in accordance with 16.2.1 without re-adjustment.

16.3 Minimum Standard

16.3.1 The usable sensitivity shall not degrade more than 6 db.

16.3.2 The audio squelch sensitivity shall not degrade more than 6 db from the value measured in 16.2.1. The receiver squelch shall not become unsquelched over the temperature range and a tight squelch adjustment shall not lock out a strong signal.

16.3.3 The modulation acceptance bandwidth shall not degrade more than 20%.

16.3.4 The adjacent channel selectivity shall not degrade more than 12 db.

16.3.5 The audio power output shall not degrade more than 2 db.

16.3.6 The hum and noise ratio shall not degrade more than 10 db from the values measured in 16.2.1.

17. HIGH HUMIDITY

17.1 Definition

High humidity denotes the relative humidity at which a receiver will operate with no more than a specified maximum amount of degradation in overall performance.

17.2 Method of Measurement

17.2.1 After one hour warm-up at standard ambient temperature and humidity, the receiver usable sensitivity (3.2), audio squelch sensitivity (5.2), modulation acceptance bandwidth (6.2), selectivity (7.2), audio power output (10.2) and hum and noise ratio (12.2) shall be noted.

17.2.2 The receiver shall be placed inoperative in a humidity chamber. The humidity shall be maintained at 90 to 95% at 50°C for a period of not less than 8 hours. After removal from the humidity chamber, visible moisture may be blown off with an air hose. The receiver shall be tested in accordance with the paragraphs specified in 17.2.1 within 15 minutes after its removal from the humidity chamber.

17.3 Minimum Standard

17.3.1 The usable sensitivity shall not degrade more than 10 db.

17.3.2 The audio squelch sensitivity shall not degrade more than 10 db from the value measured in 17.2.1, and the receiver shall not become unsquelched. Tight squelch adjustment shall not lock out a strong signal.

17.3.3 The modulation acceptance bandwidth shall not degrade more than 20%.

17.3.4 The adjacent channel selectivity shall not degrade more than 20 db.

17.3.5 The audio power output shall not degrade more than 3 db.

17.3.6 The hum and noise ratio shall not degrade more than 10 db from the value measured in 17.2.1.

18. VIBRATION STABILITY

18.1 Definition

Vibration stability is the ability of the mobile equipment to maintain specified mechanical and electrical performance during and after being vibrated.

18.2 Method of Measurement

The equipment shall be vibrated with simple harmonic motion having an amplitude of 0.015″ (total excursion 0.03″) with the frequency varied uniformly between 10 and 30 cycles per second and an amplitude of 0.0075″ (total excursion 0.015″) with the frequency varied uniformly between 30 and 60 cycles per second. The entire cycle of frequencies for each group (i.e., 10 to 30 cycles and 30 to 60 cycles) shall be accomplished in five minutes and repeated three times. The above motion shall be applied for a total period of 30 minutes in each direction, namely the directions parallel to both axes of the base and perpendicular to the plane of the base.

18.3 Minimum Standard

No fixed parts shall become loose or movable part shifted in position or adjustment under either of the two conditions of vibration. While being vibrated, the equipment shall meet all electrical requirements at standard temperature and humidity.

19. SHOCK STABILITY

19.1 Definition

Shock stability is the ability of the mobile equipment to maintain specified mechanical and electrical performance after being shocked.

19.2 Method of Measurement

Acceleration shall be applied to the manufacturer's mounting facilities and may be measured by means of a suitable accelerometer. The equipment shall be operated under standard test conditions.

19.3 Minimum Standard

The equipment shall meet all electrical requirements and suffer no mechanical damage after being subjected to a series of not less than ten impacts in each plane (total thirty). Each impact shall be not less than 20g acceleration.

ATELIER
ELEKTRA
KØBENHAVN