

5 September 1969

## MILITARY SPECIFICATION

RADIO RELAY EQUIPMENT, TRANSHORIZON  
(TROPOSPHERIC SCATTER) AN/TRC-97

## 1. SCOPE

1.1 This specification sets forth the requirements for a tactical, multi-channel radio communication system terminal, hereinafter referred to as "the radio set", capable of providing shore based communications by means of tropospheric scatter or line of sight propagation in the SHF band of 4.4 and 5.0 gigahertz for the transmission and reception of 12 or 24, channels of voice, 16 channels of teletype, and data communications at distances from 1 to 100 nautical miles. The objective is to provide a radio set having a high degree of reliability, capable of being readily operated and maintained. The radio set operates from a nominal alternating current (ac) power source of 120/208 volts, 400 hertz (Hz), 3 phase, 4 wire, wye.

## 2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on the date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

## SPECIFICATIONS

## FEDERAL

- O-E-910 - Extinguisher, Fire, Carbon-Dioxide (Hand and Wheeled Types).
- TT-E-485 - Enamel, Semi-Gloss, Rust-Inhibiting

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- MIL-W-85 - Waveguides, Rigid, Rectangular; General Specification for.
- MIL-T-152 - Treatment, Moisture, and Fungus-Resistant of Communications, Electronic, and Associated Electrical Equipment.
- MIL-V-173 - Varnish, Moisture-and Fungus-Resistant, (For the Treatment of Communications, Electronic and Associated Electrical Equipment.

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- MIL-C-3922/57. - Flanges, Waveguide (Cover) UG-407/U and UG-149/U.
- MIL-A-8625 - Anodic Coatings. For Aluminum and Aluminum Alloys.
- MIL-R-9673 - Radiation Limits, Microwave and X-Radiation Generated by Ground Electronic Equipment (as Related to Personnel Safety).
- MIL-Q-9858 - Quality Program Requirements.
- MIL-M-10304 - Meters, Electrical Indicating, Panel Type, Ruggedized General Specification for
- MIL-C-13294 - Cable, Telephone, Electrical (Infantry Field Wire, Twisted Pair, Wire WD-1/TT and WD-14/TT)
- MIL-E-16400 - Electronic Equipment, Naval Ship and Shore: General Specification.
- MIL-E-17555 - Electronic and Electrical Equipment, Accessories, and Repair Parts; Preparation for Delivery of.
- MIL-F-19207 - Fuseholders, Extractor Post Type, Blown Fuse Indicating and Nonindicating, General Specification for.
- MIL-C-26074 - Coating, Nickel-Phosphorous, Electroless Nickel, Requirements for.
- MIL-G-45204 - Gold Plating, Electrodeposited
- MIL-S-52060 - Shelter, Electrical Equipment S-144 ( )/G

## STANDARDS

## FEDERAL

- Fed Std 595 - Color

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- MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
- MIL-STD-108 - Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment.
- MIL-STD-188 - Military Communication System Technical Standards.
- MIL-STD-189 - Racks, Electrical Equipment, 19-inch and Associated Panels.

- MIL-STD-200 . - Electron Tubes; Selection and Use of.
- MIL-STD-242 . - Electronic Equipment Parts (Selected Standards).
- MIL-STD-415 . - Test Points and Test Facilities, for Electronic Systems and Associated Equipment, Design Standard for.
- MIL-STD-454 . - Standard General Requirements for Electronic Equipment.
- MIL-STD-461 . - Electromagnetic Interference Characteristics Requirements for Equipment
- MIL-STD-701 . - Lists of Standard Semiconductor Devices.
- MIL-STD-781 . - Reliability Tests Exponential Distribution.
- MIL-STD-785 . - Reliability Program for Systems and Equipments Development and Production.

(Copies of specifications, standards, drawings and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

### 3. REQUIREMENTS

3.1 General requirements.- Unless otherwise specified, the requirements of class 1 (except the low operating temperature shall be  $-40^{\circ}\text{C}$ . (see 3.3)) of MIL-E-16400 and the requirements of MIL-STD-188 for high performance equipment apply as requirements of this specification. Where the requirements of this specification and the requirements of MIL-E-16400 or MIL-STD-188 are in conflict, this specification shall govern.

3.2 Configuration.- The radio set shall consist of two transportable packages capable of being transported in, on, or by, fixed or rotary wing cargo aircraft, or truck, 3/4-ton, 4 by 4, M37 with trailer, cargo, 3/4-ton M101-A1, as applicable. One package shall be a shelter that meets the requirements of MIL-S-52060. The second package, the power accessory group, shall be a M101-A1 cargo trailer with power unit and other accessories mounted in the trailer. The M101-A1 cargo trailer, power unit and accessories listed in 3.2.4 will be Government furnished. The standard accessories listed in 3.2.5 shall be furnished with each radio set.

3.2.1 Weight.- Weight of the shelter package when loaded for transport shall not exceed 1725 pounds for 12-channel equipment or 1900 pounds for 24-channel equipment. Weight of the power accessory group shall not exceed

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4200 pounds. The Government furnished equipment of the power accessory group weighs approximately 2700 pounds (see 3.2.4 and 3.6.5.1).

3.2.2 Units. - The radio set shall consist of the following units together with the Government furnished equipment of 3.2.4 and the standard accessories of 3.2.5.

<u>Quantity</u>	<u>Description</u>	<u>Requirement</u>
(a) 1 each	Receiver-exciter group	3.6.1
(b) 1 each	Amplifier-power supply group	3.6.2
(c) 1 each	Antenna Group	3.6.3
(d) 1 each	Multiplexer group	3.6.4
(e) 1 each	Shelter, electrical equipment	3.6.5
(f) 1 each	Remote performance monitor	3.6.6

3.2.3 Beach Relay System Capability. - When required by contract, provisions to operate the Radio set as a highly reliable data link shall be incorporated (see 6.1). Such provisions shall provide the means whereby elements of the Marine Corps Tactical Data System (MTDS) may be remoted from other units of MTDS. Specifically, the Beach Relay System shall provide a highly reliable radio system data link within the Tactical Data Communications Central (TDCC) between the Data Terminal Group (AN/TYA-17) and the Data Communications Group AN/TYA-19). The Beach Relay System shall provide the interface and electrical capability to the AN/TRC-97 to allow the AN/TRC-97 to be employed as a radio link between the AN/TYA-17 and AN/TYA-19. The AN/TRC-97 when retro fitted with the Beach Relay System shall be capable of replacing the cable that exists between the AN/TYA-17 and AN/TYA-19.

3.2.4 Government furnished equipment. - The following equipment will be Government furnished to comprise part of the trailer package:

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<u>Quantity</u> <u>Radio Set</u>	<u>Nomenclature</u>	<u>FSN</u>
(a) 1 each	Trailer, cargo, 3/4 ton 2W, M101A-	2330-738-9509
(b) 3 each	Can, gasoline, Military, 5-gallon rate capacity, screw cap closure	7240-222-3088
(c) 1 each	Generator set diesel engine, PU-670 A/G	6115-933-5431

3.2.4.1 Description. -3.2.4.1.1 M101A1 Trailer, Cargo, 3/4 ton 2W. -

(a) Body Dimensions:	Width between side panels - 66 inches.
	Width between wheel housings - 45.5 inches
	Inside length - 96 inches.
	Height of sides and end - 18 inches.
(b) Curb weight:	1500 pounds.
(c) Payload capacity:	2000 pounds.

3.2.4.1.2 Can, gasoline, military 5-gallon rate capacity, screw cap closure. -

(a) Weight (containing 5 gallons fuel):	40 pounds
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3.2.4.1.3 Generator set diesel engine, PU-670 A/G. -

(a) Weight:	1270 pounds.
(b) Output data:	120/208 volts, 3-phase, 4-wire, wye, 400 Hertz, 10 kilowatts, 0.8 power factor

3.2.5 Standard accessories. - The standard accessories to be contained in each shelter package shall be in accordance with the following:

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<u>Quantity</u> <u>Radio Set</u>	<u>Description</u>
(a) 1 each	Mechanical clock, approved for use by command or agency concerned. Clock shall be equivalent to FSN 6645-599-8510.
(b) 1 each	Carbon dioxide fire extinguisher type I, size 2-1/2 in accordance with O-E-910.
(c) 1 each	10-pound sledge hammer.
(d) 1 each	Lantern, Delta Electric Company Model A-1530, or equivalent.
(e) 1 each	Chair, Folding, American Seating Company Model 60 or equivalent, or FSN 7105-282-0684.
(f) 3 each	Rod, ground; 3 feet in length.
(g) 2 each	Cable, power (for primary power)

3.2.5.1 Stowage. - Provision for proper stowage or installation of the standard accessories shall be made.

3.2.5.2 All nonstandard parts shall be in accordance with MIL-E-16400 and shall be subject to approval by command or agency concerned.

3.3 Operating conditions. - The radio set shall be designed and constructed to operate as specified herein under the following conditions:

- (a) Temperature, operating: -40 to +65°C.
- (b) Altitude, operating: Sea level to 12,000 feet.
- (c) Humidity: To 95 percent relative humidity.
- (d) Salt atmosphere: As encountered in coastal regions.
- (e) Sand dust: As encountered in high sand and dust regions, such as desert areas.
- (f) Rainfall: As encountered in tropic regions.
- (g) Wind conditions: 60 miles per hour (m.p.h.) with gusts to 100 m.p.h.

- (h) Wind and ice load: To 4.5 pounds per square foot total on both surfaces of antenna.
- (i) Inclination: Up to 20 degrees from the normal position.

3.3.1 Non-operating conditions. - The radio set shall not suffer any damage or adverse effects from the following transit and storage conditions:

- (a) Temperature: -62° to +75°C.
- (b) Altitude: Sea level to 30,000 feet.
- (c) Humidity: To 95 percent relative humidity.
- (d) Vibration: Munson and Perryman Road Courses, Aberdeen Proving Grounds, Maryland
- (e) Shock: Shelter flat and rotational drop tests.
- (f) Salt atmosphere: As encountered during ocean transport.
- (g) Sand and dust: See 3.3 (e)
- (h) Rainfall: See 3.3 (f)
- (i) Wind conditions: 80 m.p.h. with gusts to 100 m.p.h.
- (j) Wind and ice load: See 3.3 (h)
- (k) Thermal shock: 100°F. change in 5 minutes.
- (l) Inclination: Any position.

3.4 Design. - The radio set shall be designed and constructed to be readily transportable and capable of providing 2-way multichannel communication. While the primary purpose of the radio set is to utilize the tropospheric scatter mode of operation, it shall also be capable of transmitting and receiving in the line-of-sight mode. The design of baseband intermediate frequency (I.F.) and radio frequency (R.F.) parts shall be such that the bandwidth capability may be extended up to 24 channels by the use of bandpass plug-in filters or other suitable, replaceable assemblies in accordance with MIL-E-16400. The primary requirements of this equipment are that it shall be reliable and suitable for operation and maintenance by personnel with a minimum of training, on a continuous 24 hours-per-day basis.

3.4.1 Transportability. - The radio set shall be capable of being transported by fixed wing aircraft such as type C-123, by sling or rotary wing aircraft, or by truck such as type M37, or equal, without deleterious effects of shock and vibration.

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**3.4.2 Reaction Time.-** The radio set shall be capable of operation as a tropospheric scatter link terminal within one hour after arrival in the transport condition at the prospective terminal site. This reaction time is based on the premise that a three man crew is available and that the required siting data is available.

**3.4.3 Siting kit.-** Provisions for proper physical alignment of the radio set in order to establish the correct antenna placement and alignment necessary to affect communications with another terminal shall be provided. These provisions shall incorporate, among others, the furnishing of a siting kit containing 2 pocket transits, initial antenna erection and alignment procedures, realignment procedures, material, remote signal level facilities, and other devices necessary and sufficient for the 3-man crew to establish and maintain optimum communication performance of the radio set under tactical conditions. Provisions for stowing and securing the kit in the shelter shall be made.

**3.4.4 Blackout protection.-** Provisions for blackout protection with a manual override switch shall be provided. A suitable blackout curtain shall be provided for operation when personnel access door or radio equipment is left in the open position. The requirements for cotton duck webbing and enclosures of MIL-E-16400 shall apply. Color of curtain shall be black. Curtain may assist in providing dripproof protection under the provisions of 3.7(b) (2).

**3.4.5 Equipment cooling.-** The radio set shall be designed and constructed to operate under the conditions specified (see 3.3.).

**3.4.6 Electrical performance.-** The radio set shall be designed to operate and maintain specified performance from power sources having the following characteristics:

- |                                  |                                 |
|----------------------------------|---------------------------------|
| (a) Potential (steady state):    | 120/208 volts $\pm$ 10 percent. |
| (b) Phase:                       | 3 phase, 4-wire, WYE.           |
| (c) Fluctuation in potential     | $\pm$ 2 percent.                |
| (d) Rate of change of voltage:   | 2.5 percent per second.         |
| (e) Frequency (steady state):    | 400 Hz, $\pm$ 5 percent.        |
| (f) Fluctuation in frequency:    | $\pm$ 1 percent.                |
| (g) Rate of change of frequency: | 2.5 percent per second.         |



**3.4.6.1 Electrical supply variations.**- The radio set shall not be required to deliver specified performance during periods when the electrical power source varies from the specific steady state value by more than the specified tolerance value. Operation of the radio set, though degraded, shall still be possible with voltage variations of up to  $\pm 30$  percent and frequency variations of  $\pm 15$  percent. The radio set shall not sustain damage or alteration of characteristics when such variations are experienced in the power source for periods of 10 seconds with a frequency of one every 5 minutes. In the event of variations in excess of  $\pm 30$  percent in voltage or  $\pm 15$  percent in frequency, or complete power source failure, the radio set shall "fail safe".

**3.4.6.2 Power consumption.**- Under normal operating conditions, the radio set shall require not more than 7.0 kilowatts of 0.8 power factor primary power.

**3.4.7 Maintenance and operation.**- The radio set shall be capable of being aligned, adjusted, and maintained, where practicable, without the use of external test equipment or tools. In-circuit indicators, monitors, and alarms shall be utilized to the maximum extent possible.

**3.4.7.1 Modular construction.**- The radio set shall be designed and constructed to utilize modular construction techniques wherever possible. The number of removable sub-units employed shall be consistent with good engineering practice. A subunit shall not be construed to mean a chassis but units or circuitry within a chassis. All modular assemblies performing identical functions, such as amplifying circuits or low voltage power supplies, shall be identical and interchangeable with like modular assemblies throughout the set. Every effort shall be made to minimize the number of modular assemblies employed to accomplish a specific function.

**3.4.7.2 Human factors engineering.**- The radio set shall be human engineered from a maintenance and operational point of view.

**3.4.8 Tools.**- Tools, equipments, materials, and devices necessary to assemble and erect the antenna group, perform operator maintenance, alignment, and test of the radio set shall be provided as an integral part of the radio set.

**3.4.9 Equipment heat.**- Heat generated by the radio set shall be dissipated outside the shelter. A baffle or other means shall be provided to utilize the heat generated by the power amplifier to heat the shelter during cold weather.

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**3.4.10 Cable entrances, hatches, and ports.**- Cable entrances, hatches and ports shall be so configured on the shelter package that proper and convenient operation of the radio set may be established and maintained while the shelter package is stowed on the truck, 3/4-ton, 4 by 4, -M37.

**3.4.11 Power distribution.**- The radio set shall be provided with suitable power distribution protected with circuit breakers. Shelter lighting and convenience outlets shall be provided as required.

**3.4.12 Reliability**

**3.4.12.1 Reliability program.**- The contractor shall establish and implement a reliability program which is in accordance with MIL-STD-785, except that the following paragraphs of MIL-STD-785 shall not apply:

- a. Program review
- b. Reliability
- c. Those portions of "Reliability Interface Compatibility" concerned with maintainability, human resources, safety engineering, and standardization program plans.

The program plan shall be submitted to the command or agency concerned for approval 30 days after contract award.

**3.4.12.2 Mean time between failures (MTBF) shall be 1000 hours.**

**3.4.13 Microwave and X-ray radiation.**- The contractor shall prepare and submit data concerning microwave and x-ray radiation in accordance with MIL-R-9673. The contractor shall prove by computation, charts, graphs, tables, instrumentation, and any other means necessary that the radio set shall not radiate microwave and x-rays in excess of harmless limits in any portion of the equipment where personnel may be exposed during normal operation.

**3.4.14 Parts, materials and processes.**- Parts, materials and processes shall be in accordance with MIL-E-16400 except as otherwise specified herein. The selection of class, grade, or type of materials and parts shall be such that, when mounted in the equipment, the part or material will perform its intended function under the operating conditions of 3.3. Particular attention shall be paid to the provisions of MIL-STD-242, MIL-STD-701, and the acceptable and unacceptable material requirements of MIL-E-16400.

3.4.14.1 Battery use restricted.- The provisions of MIL-E-16400 regarding protection of, and construction of, the equipment and battery compartment apply to any Government furnished batteries and any other batteries that may be specifically authorized for use.

3.4.14.2 Tropicalization.- Tropicalization of the complete radio set will not be required. Wherever possible, materials used in the equipment shall not in themselves be nutrients for fungi or susceptible to deterioration by moisture and fungi. If not possible to use such materials for certain items required in the equipment, such items shall be given a moisture-fungus-proofing treatment prior to assembly in the equipment, or the areas in the equipment where such items are used shall be coated with a moisture-and-fungus resistant varnish in accordance with MIL-T-152 and MIL-V-173 prior to delivery.

3.4.14.3 Battle short switches.- Battle short switches are not required.

3.4.14.4 Blown fuse indicators.- Blown fuse indicators conforming to type FHL-S of MIL-F-19207 and of a size conforming to circuit use, shall be furnished.

3.4.14.5 Cable entrances.- For equipment mounted on the interior of the shelter package, the requirements for cable entrances of MIL-E-16400 do not apply. Final determination of sufficiency or adequacy of interconnection cabling of equipments shall be made by the command or agency concerned.

3.4.14.6 Time meters.- Time meters shall be provided in accordance with MIL-E-16400. The time meters shall be provided to record main power to the shelter, power amplifier filament on time, and power amplifier beam on time. In addition to the foregoing, any element of the system which may be operated separately from the main power to the shelter shall have a time meter.

3.4.14.7 Electrical indicating meters.- Electrical indicating meters in accordance with MIL-M-10304 shall be provided as required, and where indicated specifically in this specification.

3.4.14.8 Indicator lights.- Indicator lights shall be colored as follows:

Yellow	Open
Amber	Abnormal but not immediately dangerous condition.

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Blue	Closed (shut)
Green	Normal condition
Red	Dangerous or emergency condition requiring immediate attention or corrective action.
White	Power-on or power available.

**3.4.15 Controls, indicators, and panel layout.**- The appropriate requirements of MIL-E-16400 apply (see 3.4.7 and 3.4.7.2). The classification of controls required by MIL-E-16400, shall be approved by the command or agency concerned.

**3.4.15.1 Tactile identification.**- Tactile identification of controls will not be required unless the application of 3.4.7 and 3.4.7.2 to system design considerations make it necessary or desirable.

**3.4.15.2 Control Locks.**- Control locks shall be employed throughout the system where operating conditions dictate such a requirement (see 3.3). Recommendations shall be made to the command or agency concerned regarding application and type of control locks to be employed.

**3.4.16 Operator's position.**- An operator's position shall be provided at an appropriate location inside the shelter package. Provision for a slide-out writing surface at desk height, properly illuminated, shall be made. Adequate space for the use of the chair specified in 3.2.5(e) shall be provided.

**3.4.16.1 Functions.**- Located at the operator's position shall be the handset, properly secured when not in use, associated with the order wire or service channel unit together with the appropriate primary or remote controls associated with the functioning of the order wire. Main power switches for all installed equipments and air-flow interlock alarm indicators shall be provided, if practicable.

**3.4.16.2 Human engineering.**- The requirements of 3.4.7.2 shall apply. The functioning of the operator's position, and its layout, shall be a portion of the integrated human engineering design of the radio set.

**3.4.17 Electrical equipment racks.**- Electrical equipment racks designed to support or secure installed equipment within the shelter package shall con-

form in width, and the horizontal and vertical spacing of the mounting holes on the front vertical members, to the requirements of MIL-STD-189.

### 3.5 Functional requirements.

3.5.1 Site restrictions.- There shall be no site restrictions present within an area of 1 mile radius.

3.5.2 Separation distance.- Sites for communication between two radio set terminals operating in either the line-of-sight or troposcatter mode shall be located from 1 to 100 nautical miles apart.

3.5.3 Communication independence.- Communication between two radio sets shall be independent and provide simultaneous transmission and reception (full duplex) at each radio set.

3.5.4 Frequency band.- The operating frequency of the radio set shall be selectable in the band of 4.4 to 5.0 gigahertz (GHz).

3.5.5 Tuning and Tuning ease.- The radio set shall be tunable over the 4400 to 5000 megahertz (MHz) frequency range in 500 kilohertz (kHz) increments. Thus, the operating carrier frequencies shall be 4400 MHz, 4400.5 MHz, 4401 MHz, 4401.5, and so forth, which shall read in channels numbered 0000 through 1199 throughout the radio set. An experienced operator shall require less than 5 minutes to tune all elements necessary to establish communication on a new frequency assuming that communications had previously been established. Special tools shall not be required to accomplish the tuning function. All tuning controls shall indicate channel numbers, with the number appropriate to the frequency band. Necessary and sufficient identification plates in accordance with MIL-E-16400 shall be provided at appropriate locations on the radio set to assist an operator in the procedure of frequency change or tuning of the radio set to establish or reestablish communication. Particular attention shall be given to the provisions for dial and vernier marking of MIL-E-16400 regarding controls, indicators, and panel layout to achieve a system capable of efficient operation under tactical conditions. These provisions may be considered as a portion of the requirements of 3.4.7.2.

3.5.5.1 Multiplier chain isolation.- Elements of the multiplier chain shall be provided with isolation devices which render each element independent of any other. Alignment of any unit of this multiplier chain shall not require alignment of any other unit in the chain.

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3.5.6 Channel capacity.- The 12-channel radio set shall provide facilities for 12 channels of nominal 4 kilohertz bandwidth in a baseband of 12 to 60 kHz. An order wire or service channel shall be included below 4 kHz. The 24 channel radio set shall provide facilities for 24 channels of nominal 4 kHz bandwidth in a baseband of 12 to 108 kHz. An order wire or service channel shall be included below 4 kHz.

3.5.6.1 Teletype channels.- Provisions for the transmission and reception of 16 teletype (TTY) channels over any 4 kHz channel, shall be made. The 16-channel frequency shift type modulation of MIL-STD-188 shall be used. TTY sensitivity is defined as 0 dBm to -45 dBm for 4-wire (4W) and -15 dBm to -35 dBm for 2-wire (2W) circuits. The teletype multiplex equipment shall provide for 2 and 4 wire operation, switch selectable, for each of the 16 channels within the multiplex. Compatibility with standard TH-5/TG Telegraph Terminal Equipment shall be provided.

3.5.6.2 Channel traffic capacity.- The 12-channel radio set channel traffic capacity shall be 12 voice circuits or 11 voice circuits and 16 frequency shift keying (FSK) teletype circuits, or 12 FSK digital data circuits (see 3.6.4.7), or possible combinations of the foregoing. The 24-channel radio set channel traffic capacity shall be 24-voice circuits or 23 voice-circuits and 16 FSK teletype circuits, or 24 FSK digital data circuits (see 3.6.4.7), or possible combinations of the foregoing.

3.5.7 Modulation.- The radio set shall operate with frequency modulated transmission and reception.

3.5.8 Order of diversity operation.- The radio set shall provide for dual diversity operation. Dual diversity shall be accomplished utilizing space dual diversity.

3.5.9 Spurious and harmonic radiation.- All spurious and harmonic radiation from any element of the radio set outside the frequency band of  $\pm 4$  MHz from the transmitter carrier frequency shall be greater than 80 decibel (dB) down from the transmitter carrier power. This includes the second and higher order harmonics. There shall be no degradation from optimum receiver performance when the transmitter to receiver separation is 100 MHz or more. At any given location, where one or more sets are operating, normal operating adjustments or preventive maintenance performance on one set shall not result in performance degradation to other sets nor shall the other



set's normal operation prevent maintenance, normal tuning, or operation of any other set at the source location.

3.5.10 Spurious receiving response.- The receiver input circuit selectivity shall be such that all signals which are more than 50 MHz above or below the receiver operating frequency, and which may be present at the receiver input shall be attenuated more than 80 dB. However, the receiver image frequency attenuation shall be more than 75 dB. Both the receiver shielding and the RF selectivity shall be such that any radiation from associated transmitters or independent transmitters or other radiating devices operating on frequencies outside the receiver passband shall not cause interference to the receiver.

3.5.11 Intermodulation.- In any 4 kHz channel supported by the radio set, the maximum allowable noise attributable to intermodulation distortion in the radio equipment portion shall be less than 50 dB below the test tone level with 11 channels operating and with each channel fully loaded with continuous FSK data at a level 10 dB below the normal test tone level.

3.5.12 Pre-emphasis and de-emphasis.- Pre-emphasis and de-emphasis shall be used in the transmitter and receiver portions of the radio set so that the signal to noise ratio in any data channel shall be greater than 19 dB when the receiver(s) input level is at the frequency modulated threshold (input where carrier to noise ratio is 10 dB).

3.5.13 R F facility.- Metering circuits, test points and facilities for connecting test equipment shall be provided for evaluating the R F functioning of the radio set parts. Test points shall be in accordance with MIL-STD-415.

3.5.13.1 Switching.- Provisions shall be made for switching the power output of either the exciter or the power amplifier to the dummy load or the antenna system. In tropospheric scatter mode, the exciter shall provide the input to the power amplifier. In the line-of-sight mode the exciter shall provide the input to the antenna system (see 3.6.2.11).

3.5.13.2 Safety Device.- A safety device to prevent R F circulation and destruction of the R F Power Amplifier facility shall be incorporated into the Power Amplifier.

3.5.14 Carrier frequency stability.- The radio set shall provide carrier frequency stabilities no less than the following:

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- (a) Long term - 5 parts in  $10^6$  per 6 months (estimated).
- (b) Medium term - 1 part in  $10^6$  per day.
- (c) Short term - 1 part in  $10^8$  per 2-5 microseconds.

3.6 Details of units.

3.6.1 Receiver-exciter group.- The receiver-exciter group shall include the following (not to exclude other facilities considered necessary):

<u>Quantity</u>	<u>Description</u>	<u>Requirement</u>
1 each	Exciter	3.6.1.4
2 each	Receivers	3.6.1.5
2 each	Filter facilities	3.6.1.5.21

3.6.1.1 Residual noise.- The residual noise, due to incidental frequency modulation, shall be no more than -51 dBmo unweighted relative to the zero level point.

3.6.1.2 Intermodulation distortion.- The receiver exciter group shall contribute no more than -50 dBmo unweighted intermodulation distortion relative to the zero level point when loaded with 24 channels of equivalent white noise.

3.6.1.3 Frequency response.- The frequency response shall be as follows, measured at the shelter interface:

Order wire: 700 Hz and 1300 Hz, + 2.0 dB to - 2.0 dB;  
 300, 400 and 2500 Hz, + 3.0 dB to - 3.0 dB;  
 3000 Hz, + 2 dB to -10 dB, all relative to 1 kHz.

Multiplex:  $\pm 2.0$  dB, each voice channel (Four Wire).

3.6.1.4 Exciter.- The exciter shall provide the input to either the power amplifier for tropospheric scatter mode or the antenna system for line-of-sight mode.

3.6.1.4.1 RF power output.- The RF power output shall be greater than 1 watt across the frequency range when operating in line-of-sight mode, and as required when driving the power amplifier group.



3.6.1.4.2 Frequency range. - The output frequency range shall be that required by 3.5.4. A frequency synthesizer shall be used to generate operating frequencies.

3.6.1.4.3 Frequency stability. - The frequency stability shall be as specified in 3.5.14 across the frequency range specified in 3.5.4.

3.6.1.4.4 Input. - The input of the exciter shall be compatible with the baseband output of the multiplexer group when the radio set is operated as a terminal or as a drop and repeater in a relay mode. It shall also be capable of operation with the output of the combiner or baseband amplifier of any other like radio set so the radio set may be used as a repeater in both tropospheric and line-of-sight modes without the necessity for demodulation and remodulation of each channel. An order wire or service channel circuit shall be incorporated whose input shall be independent of that provided by the multiplexer group and whose ringing tone is different from all other ringing tones or alarm tones in the radio set.

3.6.1.4.5 Metering. - All critical circuits and circuits normally used for determining proper operation of the exciter shall be metered (see 3.4.7, 3.4.8, 3.4.14, and 3.4.15). Meters shall be of ruggedized type conforming to MIL-M-10304.

3.6.1.4.6 Residual noise. - The residual noise, due to incidental frequency modulation, shall be as specified (see 3.6.1.1).

3.6.1.4.7 Intermodulation distortion. - The intermodulation distortion shall be as specified (see 3.6.1.2).

3.6.1.4.8 Modulating frequencies. - The modulating frequencies shall be as follows:

Order wire service channel:	300 Hz to 4 kHz
Multiplex channels:	12 kHz to 60 kHz for 12 channels 12 kHz to 108 kHz for 24 channels

3.6.1.4.9 Emphasis. - Emphasis shall be as defined (see 3.5.12).

3.6.1.4.10 Frequency deviation. - The frequency deviation shall be as follows:

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Order wire:	$\pm 31.1$ kHz peak at -15 dBm input, 1 kHz
Multiplex:	For 12 channels, $\pm 328$ kHz peak at -12.7 dBm rms, white noise input- For 24 channels, plus or minus 376 kHz peak at -20.5 dBm rms, white noise input

3.6.1.4.11 Frequency response. - The frequency response shall be as specified (see 3.6.1.3).

3.6.1.4.12 Impedances. - The impedances shall be as follows:

Order wire:	600 ohms, $\pm 10$ percent
Repeater input (traffic):	135 ohms, $\pm 10$ percent, balanced
Multiplex input (traffic):	75 ohms, $\pm 10$ percent
RF output:	Waveguide flange, for RG-95/U wave- guide in accordance with MIL-W-85.

3.6.1.5 Receiver. - The receiver shall be a low noise receiver capable of receiving and demodulating received signals from either the antenna group or the auxiliary antenna group on either the tropospheric scatter or line-of-sight modes of operation. The receiver shall utilize a tunnel diode preamplifier with appropriate preselection to obtain a noise figure measured at the antenna terminals of 5.3 dB or better, depending on the current state of the art, and shall not be limited by special maintenance or operating features. The receiver noise figure shall automatically be a 11 dB or less if the low-noise device fails (fail-safe operation). Separate power supplies for each receiver are required.

3.6.1.5.1 Diversity combiner. - The receiver shall be capable of dual diversity operation. Diversity action shall be achieved by means of maximal ratio combining. The dual diversity output shall be constant within 1 dB with the receiver input signals at any point within their normal range of operation.

3.6.1.5.1.1 Noise band filters. - Replaceable plug-in filters shall be provided for out-of-band sampling appropriate for 12 and 24-channel operations.

3.6.1.5.2 Input frequency. - The input frequency and tuning shall be as required (see 3.5.4 and 3.5.5).

3.6.1.5.3 Local oscillator. - The local oscillator shall employ a frequency generator identical to the exciter except for the modulator. Power level, output frequency and stability shall be as specified (see 3.6.1.4).

3.6.1.5.4 Bandwidth. - The IF bandwidth shall be 1.5 MHz.

3.6.1.5.5 Threshold. - The receiver, in order to utilize fully the capabilities of the tunnel diode preamplifier, shall employ a threshold extension device which improves the normal FM threshold of the receiver or extends the usable sensitivity of the receiver by at least 7 dB over that of an equivalent FM receiver.

3.6.1.5.6 Receiver output. - The output circuits of the receiver for the 12 or 24-channel baseband shall have the capability of feeding the multiplexer group (3.6.4). The order wire baseband, including order wire ringing tone, shall be fed to a handset receiver and order wire ring to be provided as part of the receiver. The ringing tone shall be different from all other tones used in the radio set. Order wire level for a drop repeater shall be a -15 dBm at 600 ohms. Traffic and pilot tone baseband output to the multiplexer shall be -25 dBm  $\pm$ 10 dB at 75 ohms.

3.6.1.5.7 Receiver monitor. - The receiver monitor shall provide a means to identify the receiver or receivers which are contributing to the output of the diversity combiner. This indication shall include the operation of a local indicator and shall provide a facility for each receiver for operation of a monitor to a remote location (see 3.6.6).

3.6.1.5.8 Maximum signal. - The receiver shall operate normally (with low noise device disabled) and meet the intermodulation requirement with the radio set operating as a line-of-sight terminal and like radio set as the other terminal to a distance of 1 nautical mile. Reception of signals in excess of this level shall not affect the minimum usable signal of the receiver at any later time.

3.6.1.5.9 Receiver calibration. - Means shall be provided to inject a signal into the waveguide run(s) for the purpose of receiver calibration, from a suitable signal generator, from within the shelter without disconnecting the waveguide.

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3.6.1.5.10 Recorder output. - A monitor circuit and output amplifier for driving a suitable recorder shall be provided for each receiver and the combiner to permit monitoring the received signal level.

3.6.1.5.11 Metering. - All critical circuits and circuits normally used in tuning of the receiver shall be metered (see 3.4.7, 3.4.8, 3.4.14 and 3.4.15). Meters shall be of the ruggedized type in accordance with MIL-M-10304.

3.6.1.5.12 Frequency response. - The receiver frequency response shall be as specified (see 3.6.1.3).

3.6.1.5.13 Output impedance. - The output impedances shall be as follows:

Order wire:	600 ohms, $\pm 10$ percent, including drop repeater.
Multiplex:	75 ohms, $\pm 10$ percent.
Repeater:	135 ohms, $\pm 10$ percent.

3.6.1.5.14 Output Level. - The output levels shall be as follows:

Order wire:	-15 dBm
Multiplex:	-25 dBm $\pm 10$ dBm per traffic channel.

3.6.1.5.15 Local oscillator radiation. - The receiver local oscillator radiation shall be -98 dBm, maximum.

3.6.1.5.16 Intermodulation distortion. - The intermodulation distortion shall be as specified (see 3.6.1.2).

3.6.1.5.17 Residual noise. - The receiver residual noise shall be as specified (see 3.6.1.1).

3.6.1.5.18 Spurious response. - Undesired signals outside a receiver bandwidth of 50 MHz above and below the receiver center frequency may be 80 dB above an input signal level of -9 dBm without affecting receiver sensitivity.

3.6.1.5.19 Frequency stability. - The receiver frequency long term stability shall be 0.0005 percent maximum (local oscillator) per six months.

3.6.1.5.20 Input impedance.—The input impedance shall be 50 ohms nominal using a type N connector.

3.6.1.5.21 Filter facilities.— Filter facilities, as required, shall be provided for the receivers. Selectivity, insertion loss, voltage standing wave ratio, frequency separation of received signal capabilities, bandwidth, and so forth shall be approved by the command or agency concerned.

3.6.1.6 Receiver-exciter power supply.— The receiver exciter power supply shall have provisions for circuit undervoltage and overvoltage protection.

3.6.2 Power amplifier group.— The power amplifier shall amplify the output of the exciter to a power level of greater than 1 kilowatt for Tropospheric scatter transmission. The power output shall stabilize within a  $\frac{1}{2}$  hour period and shall remain at a maximum power output  $\pm 1$  dB but in all cases greater than 1 kilowatt. The power amplifier shall have self-contained power supplies and blowers as required. Due consideration shall be given to temperature precautions of MIL-E-16400.

3.6.2.1 Start-up time.— The power amplifier on initial operation shall be at full power operation within 5 minutes of application of primary power to the power amplifier as a whole, and within 3 seconds after operation of the switch controlling the anode voltage supplies. These specified starting times assume that all necessary tuning adjustments have been made during previous operation. The retune provisions of 3.5.5 apply to operation where the power amplifier has previously been operating on another frequency.

3.6.2.2 Front panel controls.— Controls and meters required for normal operation and monitoring of the power amplifier shall be incorporated into the front panel.

3.6.2.3 Metering.— Critical circuits and circuits normally used in tuning the power amplifier shall be metered. A means to readily determine forward and reflected power levels and the voltage standing wave ratio (VSWR) shall be provided.

3.6.2.4 Test equipment and tools.— Test and measuring equipment, and tools necessary to assemble, adjust, tune, or operate the power amplifier shall be provided as an integral part of the power amplifier (see 3.4.8).

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3.6.2.5 Overload and RF energy protection.- Devices shall be provided with the power amplifier for protection from damage due to overload, excessive heating, or other causes that may tend to damage the power amplifier. Circuit breakers shall be of the magnetic relay trip type provided with a means of quick identification of the tripped breaker(s).

3.6.2.6 Control interlocks.- Control interlocks shall be incorporated to prevent damage to the power amplifier due to improper manipulation of any controls located on the power control panel.

3.6.2.7 Reflected RF power protection.- A protective device or an interlock shall be incorporated to protect the power amplifier when the power amplifier load becomes excessive. Use of an interlock requires that appropriate supply voltages be removed from the power amplifier when the load becomes excessive. The interlock shall be provided with a manual override and the interlock functioning shall be adjustable over a 10 percent range of the VSWR recommended for normal operation. An alarm to indicate high RF reflected power shall be provided.

3.6.2.8 Low RF power alarm.- An audible alarm shall sound when the average RF power output falls below a certain level, between zero and the nominal operational average power, as preset on a calibrated front dial by an operator. Facility shall be included for a low RF power alarm which shall automatically be disabled when the power amplifier is not intended to be in operation; however, provision must be included for test of its proper operation. An indicator lamp shall be provided in conjunction with the low RF power alarm.

3.6.2.9 Indicators.- Lamp indicator shall be used to indicate the operating status of the power amplifier and to facilitate the quick identification of open interlocks and overloads. Lamps shall afford good visibility and color used to identify operational status shall be in accordance with 3.4.14.8.

3.6.2.10 Output impedance.- The output of the power amplifier circuit shall enable the amplifier to deliver its rated power into a load with the same electrical characteristics as those of the transmission line system between the power amplifier and the antenna.

3.6.2.11 Dummy load.- An RF dummy load shall be provided as a part of the power amplifier capability. The dummy load shall absorb the maximum power output of the power amplifier in the frequency band (see 3.5.4) with a nominal load impedance equivalent to that of the transmission line system

between the power amplifier and the antenna and with a VSWR not to exceed 1.3:1. The dummy load shall be air cooled.

3.6.2.12 Reduced power operation.- The power amplifier shall be capable of operation at output powers below the nominal 1 kilowatt level.

3.6.2.13 Power supply control calibration.- To enable the operator to know in advance what voltage or current is to be delivered by a supply, controls shall be equipped with calibrated  $\pm 10$  percent dials marked in appropriate units and values.

3.6.2.14 Input impedance.- The nominal input impedance of the power amplifier shall be 50 ohms.

3.6.2.15 Output impedance and connection.- The power amplifier output connector shall be a type UG/407U in accordance with MIL-F-3922/57, and the output impedance shall be nominal 50 ohms.

3.6.2.16 Input power requirements.- The input power requirement is 1 watt.

3.6.2.17 Residual amplitude modulation.- The residual (incidental) amplitude modulation shall be -50 dB.

3.6.2.18 Harmonic Output.- The harmonic output shall be 80 dB below the carrier, outside the carrier frequency band of carrier frequency  $\pm 4$  MHz.

3.6.3 Antenna group.- The antenna group shall be designed to provide maximum flexibility in operating as a line-of-sight terminal antenna group and space dual diversity.

3.6.3.1 Frequency range.- The antenna group shall meet the requirements specified over the frequency range (see 3.5.4.).

3.6.3.2 Side lobes.- Side lobes within  $14^\circ$  from the main lobe shall be at least 20 dB below the main lobe. From  $\pm 14^\circ$  to corresponding  $\pm 22^\circ$  away from the main lobe the side lobes shall be at least 26 dB below the main lobe. All other side lobes shall be at least 30 dB below the main lobe.

3.6.3.3 Antenna Gain. - The antenna gain shall be greater than 38 dB over a half-wave dipole.

3.6.3.4 VSWR.- The VSWR of the antenna group as seen from the transmitter and receiver terminals shall be less than 1.25:1.



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3.6.3.5 Alignment.- Alignment shall be as specified in 3.4.3 and 3.4.8.

3.6.3.6 Adjustment.- The antenna assembly used shall adjust between  $\pm 10$  degrees and  $\pm 5$  degrees in elevation and  $\pm 45$  degrees in azimuth, referenced to a level plane and a true vertical, after erection. The antenna(s) shall indicate the true angle of the antenna and its support with reference to the horizontal and vertical. It shall automatically indicate the optimum antenna positioning of the antenna readable by persons adjusting the antenna azimuth and elevation for optimum reception.

3.6.3.7 Reflector.- The reflector shall have as small an aperture diameter as is consistent with the performance criteria outlined herein.

3.6.3.8 Reflector tolerance.- The reflector surface shall not deviate from the required theoretical contour by more than  $\pm 1/6$  of an inch.

3.6.3.9 Space dual diversity.- When space dual diversity is used, the antenna group shall transmit and receive on both planes of polarization simultaneously. Isolation between planes of polarization shall be greater than 30 db at all times.

3.6.3.10 Feed horn and support structure.- The feed horn and support structure shall present a minimum surface to the reflector in accordance with good engineering design practice to minimize antenna system side lobes.

3.6.3.10.1 Space diversity.- For space diversity operation, the feed horn shall be a dual polarized horn.

3.6.3.10.2 Illumination taper.- For maximum efficiency, the illumination taper shall be 10 to 11 dB.

3.6.3.10.3 Adjustments.- The feed horn assembly shall be adjustable for final alignment of the beam with the reflector positioned within the adjustment ranges specified in 3.6.3.6.

3.6.3.10.4 Deicing.- The feed horn shall provide deicing facilities.

3.6.3.11 Transmission line system.- The transmission line system shall suitably interconnect the elements of the receiver, power amplifier, exciter and feed horn as appropriate to the transmission and reception modes selected.



3.6.3.11.1 Pressurization. - That portion of the transmission line subject to environmental conditions outside the shelter shall be appropriately pressurized with dehydrated air, if required, to provide optimum performance under any possible operating conditions (see 3.3).

3.6.3.11.2 Arc alarm. - Means shall be provided to detect and indicate intermittent or continuous arcing in the transmission line. This may be combined with the alarm requirements of 3.6.2.7, if appropriate.

3.6.3.11.3 Waveguide sections. - All waveguide sections (flexible waveguide) shall be of the same type and length.

3.6.3.12 Antenna support structure. - The antenna support structure shall suitably support the antenna(s) under the operating conditions of 3.3 and provide optimum performance required by high gain systems.

3.6.3.12.1 Ground anchors. - Ground anchors and the facilities for driving them shall be provided (see 3.2.5).

3.5.3.12.2 Guy wires. - Guy wires used shall be of the same diameter.

3.6.3.13 Stowage. - Transport and stowage of the antenna support structures, feed horns and support structures, and reflectors in the trailer package shall be provided for. Suitable means shall be provided to protect more fragile items such as the feed horns, waveguide assemblies and supports.

3.6.4 Multiplexer group. - A 12 or 14-channel multiplex group as specified by the Contract (see 6.1) shall be supplied as a part of the radio set to accept the outputs of various voice, data and teletype signal circuits, convert them into a form suitable for transmission over the link, and reconvert them into a form suitable for use at the receiving end. The multiplex group shall provide for suitable interconnection with other groups of the radio set as required, and suitable operation of either input or output. The multiplex group shall provide frequency division multiplexing with synchronizing pilot carrier in accordance with MIL-STD-188.

3.6.4.1 Channel capacity. - Channel capacity shall be as specified (see 3.5.6).

3.6.4.2 Terminations. - The multiplex group shall contain provisions for switching to either 2-wire or 4-wire operation.

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3.6.4.3 Channel impedance.- The audio input and output 4 kHz audio frequency channel shall be nominally  $600 \pm 10$  percent ohms.

3.6.4.4 Multiplexing arrangements.- The 12-channel radio set shall have voice channels 1 through 12 located in the baseband from 60 kHz to 12 kHz in an alternating upper and lower sideband scheme. The 24-channel radio set shall have voice channels 1 through 24 located in the baseband from 12 kHz to 108 kHz. The 24-channel radio set shall be capable of operation in either single or twin sideband, in accordance with MIL-STD-188.

3.6.4.4.1 Output voice level.- An output voice level range of 0 dBm to -20 dBm shall be provided. The adjusted level shall be stable within  $\pm 2$  dBm. The +7 dBm to -20 dBm refers to the average voice power.

3.6.4.4.2. Input voice level. The multiplexer group shall accept input voice levels of 0 dBm, -4 dBm, and -10 dBm adjustable by plugable submodules.

3.6.4.5 Signaling.- The multiplexer group shall contain facilities to respond to and provide 20 Hz ringdown signaling for each telephone channel. A source of 20 Hz power adequate for ringing 10 circuits simultaneously shall be provided. Necessary devices to remote all alarm functions shall be provided.

3.6.4.6 Test functions.- The multiplexer group shall provide built-in testing functions as required for alignment, set-up, testing, maintenance, and operation.

3.6.4.6.1 Test handset.- A 4-wire test telephone handset, sound powered, with attached cord and plug for entering the multiplex jack panel shall be provided as part of each radio set.

3.6.4.7 Frequency shift keying digital data transmission requirements.- The multiplexer group shall be capable of processing FSK digital data transmissions of bit rates of 1500 bits per second, for transmission or reception, with the characteristics specified in 3.6.4.7.1 through 3.6.4.7.19.

3.6.4.7.1 Modulation.- FSK - lower frequency is 1225 Hz and upper frequency is 1325 Hz.

3.6.4.7.2 Frame. - A standard transmission frame consists of 128 bits and is composed of information bits, coded synchronization, redundant marks for

timing, and interleaved odd-parity check bits. The interleaved odd-parity shall provide error detection but not error correction.

3.6.4.7.3 Mark and space.- A mark is transmitted as a transition from one frequency state to the other. A space is represented by the absence of any change in frequency. The method of representing markings by frequency transitions, plus an insertion of redundant marks in the transmitted message provides sufficient information at the receive end to derive reliable timing. The received data shall be clocked with the derived timing and transferred to the data using equipment.

3.6.5.7.4 Error rate.- An error rate shall be less than 24 erroneous frames per hour for a 1500 bit per second rate. This error rate shall not be exceeded more than ten times per month.

3.6.4.7.5 Circuit type.- 4-wire termination.

3.6.4.7.6 Harmonic distortion.- Total harmonic distortion shall be less than  $\pm 5$  percent when measured with a 1000 Hz  $\pm 20$  Hz test tone at a level of -4 dBm.

3.6.4.7.7 Impedance mismatch.- Maximum acceptable impedance mismatch between two sections of one circuit shall be in accordance with MIL-STD-188.

3.6.4.7.8 Frequency displacement. - Single tone shall not be displaced more than  $\pm 1$  Hz for the frequency range of 380 to 3100 Hz.

3.6.4.7.9 Transmission gain.- The nominal level measured at the receive end of the circuit shall equal the level measured at the transmit end of the circuit within the limits of  $\pm 0.5$  dB. Measurement made with 1000 Hz  $\pm 20$  Hz test tone at -4 dBm level.

3.6.4.7.10 Transmission gain variation.- The instantaneous variation in transmission gain shall not exceed  $\pm 5$  dB; short term shall not exceed  $\pm 1$  dB or -2 dB; and long term shall not exceed  $\pm 4$  dB.

3.6.4.7.11 Noise (excluding impulse noise). - Median psophometric noise from all sources during maximum message loading shall not exceed 200 picowatts.

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3.6.4.7.12 Crosstalk. - Far-end and near-end crosstalk from the same 4-wire circuit plus the far-end and near-end crosstalk from all circuits shall be included in the median psophometric noise. Measurement shall be by recommended psophometer.

3.6.4.7.13 Companders and echo suppressors. - Compression circuitry and echo suppressors shall not be used.

3.6.4.7.14 Circuit continuity. - Circuit interruption shall not be tolerated. Circuits are used 100 percent of the time during data transmission.

3.6.4.7.15 Input-output requirements - impedance. - Circuit input-output impedance shall be 600 ohms  $\pm 10$  percent, balanced over the frequency range of 300 to 3500 Hz.

3.6.4.7.16 Input-output requirements-level. - Input-output levels shall be  $0 \pm 1$  dBm at the 4-wire terminals.

3.6.4.7.17 Amplitude - frequency distortion. - The -3 dB points, with respect to 100 Hz, shall be at or below 380 Hz and at or above 3100 Hz. For all frequencies between 950 and 2625 Hz the amplitude variation shall be less than  $\pm 2$  db with respect to 1000 Hz.

3.6.4.7.18 Envelope delay - Maximum variation of envelope delay for frequencies between 950 Hz and 2625 Hz shall be not greater than 500 microseconds. The maximum variation of envelope delay for frequencies between 600 Hz and 3000 Hz shall be not greater than 1000 microseconds.

3.6.4.7.19 Impulse noise. - Impulse noise peaks of 100 microseconds duration or greater, positive or negative, between the levels of 20 dB below and 10 dB below the signal level shall exceed not more than 100 per hour. Peaks exceeding 10 dB below signal level shall not exceed 8 per hour.

3.6.4.8 Gold finish. - Where gold finish is required, it shall be in accordance with the requirements of type II, Grade B, Class 5 of MIL-G-45204.

3.6.4.9 Electroless nickel coating. - Electroless nickel coating, where required, shall be in accordance with class 2, Grade A of MIL-C-26074.

3.6.4.10 Slides and extending cables.- The multiplexer shall have slides (locking) and permanently attached extending cables on drawers to enable maintenance of the system while operating.

3.6.4.11 Monitor telephone.- A monitor telephone 2W/4W shall be provided on the multiplex.

(a) 2W operations shall permit the operator to the local subscriber separately or both subscribers simultaneously; the far end of the link subscriber is not run separately or both subscribers simultaneously; the far end of the link subscriber is not rung separately.

(b) 4W operations shall permit the operator to ring in either direction but not both simultaneously.

3.6.4.12 Multiplex test set.- A multiplex test set shall be provided. It shall have a high impedance vacuum tube voltmeter (VTVM) capability for limited use elsewhere in the radio set and shall be operable as a pilot tone detector with full voice/data loading on all channels.

3.6.5 Shelter, electrical equipment.- An Electrical Equipment Shelter, S-308 ( )/G, shall be provided in which units of the Radio Set will be mounted to form the shelter package of the Radio Set and shall be defined as follows.

3.6.5.1 Shelter construction.- Except as modified herein, the shelter shall be in accordance with MIL-S-52060.

3.6.5.2 Dimensions.- The shelter shall not exceed the following exterior dimensions:

Length	76 1/2 inches
Width (top of shelter)	74 7/16 inches
Width (bottom of shelter)	43 5/8 inches
Height	73 5/16 inches

3.6.5.3 Weight.- Gross weight of the shelter shall not exceed 525 pounds.

3.6.5.4 Skids.- Three removable aluminum skids shall be provided. The skids shall be 3 inches wide and 3 inches high and shall be the same length as the shelter. Skids shall be attached so that the ends of the skids are flush with the ends of the shelter and are removable.

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3.6.5.5 Lifting rings. - A lifting ring shall be provided at each top corner of the shelter. The inner diameter of the lift rings shall be three inches minimum. The lift rings shall be free to hang when not engaged. Each ring shall withstand a force of 5000 pounds applied in any direction without failure.

3.6.5.6 Towing rings. - The shelter shall be equipped with towing rings. The inner diameter of the towing rings shall be one and one half inch minimum. The towing rings shall withstand a force of 5000 pounds applied in any direction without failure.

3.6.5.7 Roof. - The roof shall have strips of non-skid material placed on an 18-inch perimeter of the roof.

3.6.5.8 Floor. - The floor shall have local strength over any area of three square feet to support a loading of 1500 pounds when the shelter is suspended by the four lifting rings.

3.6.5.9 Drop. - The shelter, with equipment installed, shall be subjected to the flat drop and rotational drop tests in accordance with MIL-S-52060.

3.6.5.10 Tie-down. - A tie-down cable assembly shall be provided to permit attaching the shelter to an M-37 truck.

3.6.5.11 Center of gravity. - The weight distribution of the shelter package when stowed on the 3/4 ton truck (M37) for transport, without crew, shall be such that the center of gravity of the vehicle, with payload, shall be 41 inches, maximum, above the ground and 64,  $\pm 2$ , inches to the rear of the center of the front axle.

3.6.5.12 Waveguide entrances. - Waveguide extensions and quick disconnect clamps shall be used on all waveguide entrances to the shelter.

3.6.5.13 Power transfer. - A power transfer switch and dual power entry connectors shall be provided on the shelter rear wall on the curbside of the door.

3.6.5.14 Waveguide location. - Transmit and receive waveguide, with associated cabling and covers, shall be located on both sides of the shelter door opening. It shall be possible to operate the radio set in the non-diversity mode using either the left side pair or right side pair of waveguides.

3.6.6 Remote performance monitor. - A remote performance monitor to indicate the qualitative functioning of the receivers, exciter, power amplifier, and multiplexer groups by visual means shall be provided. Indicators shall be provided to provide information to an observer of equipment failure, equipment malfunction, degraded performance, such as low RF power, increased noise-figure, high power amplifier VSWR, and so forth. The performance monitor shall provide for remote monitoring up to a distance of 1/2 statute mile from the remainder of the radio set. Particulars of the remote performance monitor such as monitor functioning, interconnection with the remainder of the radio set, size, weight, and power consumption shall be as approved by the command or agency. The connection between the remote performance monitor and the radio set shall be made with standard field wire, WD-1/TT, in accordance with MIL-C-13294 by the operator of the radio set. This wire is not included in the equipment to be delivered by the contractor.

3.6.6.1 Visual indicators. - Color coding of visual indicators shall be in accordance with 3.4.14.8.

3.6.6.2 Intercommunication. - Provisions shall be made for intercommunication between the operator's position in the shelter package and the remote performance monitor. Suitable terminations for the use of a field telephone shall be provided as the remote performance monitor.

3.7 Enclosure. - The radio set, under the conditions indicated, shall conform to the degree of enclosure indicated, in accordance with MIL-STD-108, as follows:

<u>Condition</u>	<u>Degree of enclosure</u>
(a) Transport:	Splashproof.
(b) Operating:	
(1) With shelter personnel access door closed.	Splashproof, and enclosed, self-Ventilated.
(2) With shelter personnel access door open.	Dripproof.

3.7.1 Installed equipment. - The equipment when installed within the shelter package shall be dripproof in the operating and nonoperating condition in accordance with MIL-STD-108.



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**3.7.2 Exceptions. -**

**3.7.2.1 Remote performance monitor. -** The remote performance monitor shall be splashproof in accordance with MIL-STD-108. In the event it is stowed for transport in other than the shelter package, it shall be protected by, or enclosed in a watertight enclosure such as a watertight transit case, in accordance with MIL-STD-108.

**3.7.2.2 Feed horns and waveguide assemblies. -** In the event feed horns and waveguide assemblies are stowed for transport in other than the shelter package, they shall be protected from the environment by a protective neoprene jacket. End caps which are the captive type and rugged shall be used to protect the ends of the assemblies and horns.

**3.8 Finishes, priming, and painting. -** The radio set shall be finished in accordance with MIL-E-16400 and with the following colors:

- |                                       |                                                                                            |
|---------------------------------------|--------------------------------------------------------------------------------------------|
| (a) Front panels                      | - Gray, color #36373 of Fed. Std. 595 enamel lustreless, or #26373 of Fed. Std. 595 enamel |
| (b) Racks, Shelter walls and ceiling. | - Green, color #24533 of Fed. Std. 595 enamel semigloss                                    |
| (c) Marking                           | - Black, color #27038 of Fed. Std. 595 enamel semigloss                                    |
| (d) Handles (front panel)             | - Anodized aluminum, black MIL-A-8625 Type II                                              |
| (e) Shelter floor                     | - Dark Gray, color #36118 of Fed. Std. 595 enamel, lustreless, or gray "Scotch Tread".     |
| (f) Shelter exterior                  | - Marine Corps green no. 23 per TT-E-485 enamel, semigloss, rust inhibiting.               |

**3.8.1 Unspecified finishes, priming and painting. -** All units or parts of the radio set not having specifications for finishing described in 3.8, shall be finished, primed or painted in accordance with MIL-E-16400. The colors shall be Marine Corps green No. 23.



3.8.2 Human engineering. - In the event human engineering considerations for operation, maintenance, or assembly of shelter installed equipment or antenna units indicate the use of color(s) other than as specified, either in whole or partially, the use and color shall be as approved by command or agency concerned.

3.9 Qualitative requirements. - The degree of conformance of fulfillment of qualitatively expressed requirements wherein words or phrases such as: proper, readily, suitable, necessary, convenient, normal and so forth are used shall be as determined by the command or agency concerned.

3.10 First article sample. - Prior to beginning production a sample shall be tested as specified in 4.3.

3.11 Synchro transmitters and receivers. - Synchro transmitters and receivers are not required.

3.12 Hydraulic shock. - Hydraulic shock requirements are not applicable.

3.13 Electromagnetic interference. - Electromagnetic interference requirements shall conform to MIL-STD-461, for equipment classes 1A, 1B, and 1C.

3.14 Bearings, ball. - Ball bearings of the metric series shall not be used unless specifically approved by command or agency concerned.

3.15 Workmanship. - Workmanship shall be of the highest quality and in accordance with MIL-E-16400.

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. - Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may utilize his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

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**4.1.1 Contractor's quality assurance system.** - The contractor shall provide and maintain an effective inspection and quality control system acceptable to the Government covering the supplies under the contract. The quality control system shall be in accordance with specification MIL-Q-9858. A current written description of the system shall be submitted to the cognizant Government inspector for system approval, 60 days prior to first article inspection with a copy to the command or agency concerned.

**4.1.1.1** The written description shall include flow charts showing the complete flow of material from inspection on receipt, through all manufacturing processes, to final shipment. The various processes and inspection positions shall be clearly identified on the flow charts and cross referenced to the detailed inspection procedures and criteria of the written description of the quality control system. Any changes to the approved quality control system which might affect the degree of assurance required by this specification or other applicable documents shall be submitted to the command or agency concerned for approval prior to use.

**4.1.2 Government verification.** - All quality assurance operations performed by the contractor will be subject to Government verification at any time. Verification will consist of (a) surveillance of the operations to determine that practices, methods, and procedures of the written system description are being properly applied, and (b) Government produce inspection to measure quality of product to be offered for acceptance. Failure of the contractor to promptly correct deficiencies discovered by him or of which he is notified shall be cause for suspension of acceptance until corrective action has been made or until conformance of product to prescribed criteria has been demonstrated.

**4.1.3 Tests, test equipment, and test procedures.** - The contractor shall submit a list of proposed tests and written test procedures including test equipment and tolerance limits to be used in testing first article and production equipment to the command or agency concerned, via the Government inspector, for review and approval, at least 60 days prior to beginning first article tests. Each test shall be identified in accordance with 4.2 as to classification.

**4.2 Classification of inspection.** - The method of examination and testing of the equipment fall within the following classification:

- (a) First article inspection
- (b) Quality conformance inspection
  - (1) Production inspection
  - (2) Production control inspection
  - (3) Environmental test
- (c) Reliability Testing

4.3 First article inspection. - First article inspection shall consist of all examination and testing necessary to determine compliance with the requirements of this specification. First article inspection shall consist of the tests specified in the preproduction inspection paragraph of MIL-E-16400 and approved in accordance with 4.1.3. The reliability and water cooling tests of MIL-E-16400 are not required. Measurement shall be made during the humidity test cycle as defined in 4.3.2. The tests shall be performed by the contractor prior to delivery to the command or agency concerned for operational evaluation. Testing shall be under the supervision of the Government representative and may be observed by authorized representatives of the military services.

4.3.1 First article inspection report. - The final results of the first article inspection shall be submitted via the Government representative to the command or agency concerned for review and approval. Shipment of the first article equipments for Government evaluation will be contingent upon approval of these results. Final design production approval will be subject to the Government's operational evaluation results of these prototype equipments and the conditions of acceptance.

4.3.1.1 The first article inspection report shall contain the following information:

- (a) A technical discussion relating to each examination and test with a summary of these results. Compliance or noncompliance with this specification shall be so stated.
- (b) A block diagram of each test set-up including a description of of the type of test equipment employed and dial settings.
- (c) A statement of the accuracy of the measurement taken under each test phase.

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- (d) Supplementary data to include all data recorded in the performance of these test preceded by a summary table of these data.
- (e) A detailed list of all corrections and additions to the equipment design.

4.3.1.2 The first article inspection report shall be signed by at least the test engineer, project engineer and the local Government representative prior to submission. Three copies of the test report for each prototype shall be submitted to the command or agency concerned. Two additional copies will be delivered with each equipment.

4.3.2 Humidity test. - The following measurements shall be made during the humidity test cycle at the times called for in MIL-E-16400:

- (a) Receiver
  - (1) Receiver sensitivity.
  - (2) Audio power output.
  - (3) Frequency.
- (b) Transmitter
  - (1) Radio frequency power output.
  - (2) Frequency.
- (c) Multiplexer
  - (1) Channel levels.
  - (2) Cross talk.

4.4 Quality conformance inspection. -

4.4.1 Production inspection. - Production inspection shall be made on every equipment offered for delivery. The inspection shall comprise such examination and testing as will prove the workmanship and reveal the omissions and errors of the production process such as functional and performance tests at a limited number of points, tests which detect deviations from design, tests of adjustment, and tests which detect hidden defects of material. Production inspection shall consist of the tests approved in accordance with 4.1.2 and shall include the following:

<u>Inspection</u>	<u>Reference</u>
(a) Surface Examination	MIL-E-16400
(b) Operating Test	MIL-E-16400 and 4.4.1.2

4.4.1.1 The first three production equipments shall have tests performed on them to ensure that any deficiencies indicated in the Government operational evaluation have been corrected to the satisfaction of the command or agency concerned in the production equipments. This in no way changes or modifies any requirement for resubmission or retesting called for in the contract or order.

4.4.1.2 During the operating test the equipment shall operate at least 8 hours consecutively without failure or interruptions. Each complete system shall meet this requirement prior to acceptance.

4.4.2 Production control inspection. - Production control inspection shall be performed in accordance with MIL-E-16400 except that the reliability and water cooling tests are not required. Equipments to be subjected to production control inspection shall be selected from lots of equipments which have passed production inspection. The sampling shall conform to the procedures for special inspection levels of MIL-STD-105. The inspection level shall be S-4 for normal, tightened, and reduced inspection, with an AQL of 6.5 percent for each test required by MIL-E-16400. The equipment shall satisfactorily meet the requirements of production control inspection prior to release for shipment.

4.4.2.1 Rejected lots. - If an inspection lot is rejected, the supplier may withdraw the lot from further inspection. The supplier may also rework a rejected lot to correct the defective units and reinspect the lot using tightened inspection. Rejected lots shall be kept separate from new lots and shall not lose their identity.

4.4.2.2 Non-conformance and retest. - If a sample unit fails a test specified in 4.4.2, the contractor shall immediately investigate the cause of failure and shall report to the Government inspector the results thereof and details of the corrective action taken to correct units of product which were manufactured with the same conditions, materials, processes, and so forth. The equipment shall then be retested.

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4.4.2.3 Corrective action. - If corrective action results in a change of part(s), circuit layout or the mechanical arrangement, or if the government inspector does not consider that the corrective action will enable the product to meet specified requirements, or if the contractor cannot determine the cause of failure, the matter shall be referred immediately to the contracting officer. It shall then be determined by the command or agency concerned whether correction should be made to the equipments already delivered under the contract.

4.4.3 Environmental inspection. - This inspection shall be as listed in Table I and shall normally be performed on sample units that have been subjected to and have passed production and production control inspections.

Table I - Environmental Inspection

<u>Inspection</u>	<u>Reference</u>
Temperature	MIL-E-16400
Humidity	MIL-E-16400 and 4.3.2
Shock, Vibration, Inclination and noise	MIL-E-16400
Salt Spray Test	MIL-E-16400

4.4.3.1 Sampling for inspection of equipment. - For the first environmental inspection, one radio set from the first month's production, or the first 25, whichever is less shall be selected. For subsequent environmental inspections, one radio set from each successive 25, or one per month if less than 25 are produced monthly, shall be selected.

4.4.3.2 Noncompliance. - If a sample unit fails environmental inspections, the contractor shall immediately investigate the cause of failure and shall report to the Government inspector the results thereof and details of the corrective action taken on the process and all units of products which were manufactured with the same conditions, materials, processes, and so forth. If the Government inspector does not consider that the corrective action will enable the product to meet specified requirements, or if the contractor cannot determine the cause of failure, the matter shall be referred to the contracting officer.

4.4.4 Reinspection of conforming production control and environmental inspection sample units. - Unless otherwise specified, sample units which have been subjected to and passed production control or environmental inspections, or both may be accepted on contract provided that they are resubjected to and pass production inspection after repair of all visible damage.

#### 4.5 Reliability Demonstration

4.5.1 Reliability Test Procedures. - Reliability test procedures shall be in accordance with the "Detail Requirements" of MIL-STD-781 and shall be submitted to the procuring agency for approval no later than 60 days prior to reliability testing. Reliability testing shall be run only on those equipments which have passed production inspection.

4.5.2 Qualification Test. - The qualification test shall be run on the first production unit. The test shall be conducted at test level D of MIL-STD-781 except that vibration is not required. The test shall be run for 500 hours with zero failures. Should any failures occur the equipment will be rejected.

4.5.3 Sampling Test. - One sample of production units will be randomly selected by the procuring agency for a second reliability test to be run as described in 4.5.2.

4.5.4 Failure. - Failure shall be defined as any malfunction or parameter deviation that prevents the equipment from performing within the operational requirements set forth in this specification.

4.5.5 Rejected Equipment. - The procedures of MIL-STD-781 for Corrective action shall be followed if a failure occurs. Any design changes or modifications required to achieve the specified reliability shall be at the contractor's expense.

4.5.6 Disposition of Tested Equipment. - Upon successful completion of reliability testing, tested equipment shall be returned to the production area for reinspection and reconditioning as required, and shall be subjected to production tests of 4.4.1. The equipment may be delivered as part of the contract quantity provided it meets all terms and conditions of the contract for acceptance.



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4.5.7 Burn in. - There shall be no burn in of the reliability test sample prior to reliability test.

4.5.8 Measurements. - During each measurement period (at least one in any 24 hour period). The operating test of 4.4.1 shall be performed in accordance with approved production test procedures.

## 5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements. Preparation for delivery requirements of referenced documents listed in Section 2 do not apply unless specifically stated in the contract or order. Preparation for delivery requirements for products procured by contractors shall be specified in the individual order.)

5.1 Preservation, packaging, packing and marking. - Unless otherwise specified, preparation for delivery shall be in accordance with the applicable levels of preservation, packaging, packing and marking specified in MIL-E-17555 (see 6.1).

## 6. NOTES

6.1 Ordering data. - Procurement documents should specify the following:

- (a) Title, number and date of this specification.
- (b) Provisions for beach relay system capability (see 3.2.3).
- (c) Whether a 12 or 24-channel multiplex group is required (see 3.6.4).
- (d) Selection of applicable level of packaging and packing required (see 5.1).

### 6.2 First article.

6.2.1 Invitations for bids should provide that the Government reserves the right to waive the requirement for first article samples as to those bidders offering a product which has been previously procured or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending procurement.



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6.3 Environmental Inspections. - Approval to ship may be withheld at the discretion of the Government, pending the decision from the contracting officer on the adequacy of corrective action (see 4.4.3.2).

Preparing activity:  
NAVY - EC

(Project 5820 -N400)

<b>SPECIFICATION ANALYSIS SHEET</b>		Form Approved Budget Bureau No. 119-R004
<p style="text-align: center;"><u><b>INSTRUCTIONS</b></u></p> <p>This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured in minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fill in lines on reverse side, staple in corner, and send to preparing activity (as indicated on reverse hereof).</p>		
SPECIFICATION		
ORGANIZATION (of submitter)		CITY AND STATE
CONTRACT NO.	QUANTITY OF ITEMS PROCURED	DOLLAR AMOUNT \$
MATERIAL PROCURED UNDER A		
<input type="checkbox"/> DIRECT GOVERNMENT CONTRACT <input type="checkbox"/> SUBCONTRACT		
1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?		
A. GIVE PARAGRAPH NUMBER AND WORDING.		
B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES.		
2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID		
3. IS THE SPECIFICATION RESTRICTIVE?		
<input type="checkbox"/> YES <input type="checkbox"/> NO IF "YES", IN WHAT WAY?		
4. REMARKS (Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)		
SUBMITTED BY (Printed or typed name and activity)		DATE

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