

ANNEX F**VHF REPEATER SYSTEM (MARSREPSYS)****F100. INTRODUCTION AND OVERVIEW****F110. PURPOSE**

This annex provides direction for the establishment, maintenance, and operation of the Military Affiliate Radio System (MARS) VHF Repeater System (MARSREPSYS).

F120. SCOPE

This annex applies to all MARS VHF repeater stations regardless of whether the station consists of government or privately owned equipment.

F130. CONCEPT

The MARS VHF Repeater System extends the line of sight communications range of fixed, portable, and mobile VHF communications facilities, thereby providing a more efficient utilization of the limited frequency allocations and reducing congestion in the prime lower frequencies. Additionally, the MARSREPSYS significantly improves the potential of MARS to provide telecommunications support for the Department of the Navy disaster control operations, as well as local civil disaster control, by providing a highly mobile and effective quick reaction communications capability for local state communications.

F140. ORGANIZATION

The MARSREPSYS shall be under the overall supervision of the Chief, NAVMARCORMARS and the MARS area directors and their special assistants. Within each MARS state, the state director or a designated representative shall provide the necessary control and supervision for the installation and operations of the state VHF repeater stations. A technically qualified individual, who is available and is within a reasonable distance from the repeater station to enable timely correction of malfunctions, shall be assigned as station engineer. He shall be responsible for the supervision of the station equipment installation and maintenance and shall maintain operational control of the station to assure that the station continually conforms to the specifications and operating guidelines herein.

F200. RESPONSIBILITY**F210. CHIEF, NAVMARCORMARS**

Chief, NAVMARCORMARS shall provide overall supervision for the installation and operation of VHF repeater stations within the MARSREPSYS, regardless of whether the station consists of private equipment loaned to the program or government equipment supplied to a member for this purpose.

F220. MARS AREA DIRECTOR

Each area director shall:

a. Select and appoint an Assistant to the Director (VHF FM Repeater System) to act as principal assistant and advisor per Chapter 2.

b. Initiate actions on agreements for site locations, when required.

c. Review proposed VHF repeater station locations and installation plans and recommend changes thereto for conformity to the specifications of this annex. The director shall be the only approving authority within his/her MARS area.

d. Assign VHF repeater station designator upon approval for commencement of station operation.

e. Initiate action for obtaining frequencies, as required, and provide allocation for their use.

f. Effect appropriate coordination among state directors and directors of adjacent regions and areas, as necessary, for the installation and operation of VHF repeater stations.

g. Keep Chief, NAVMARCORMARS advised on the installation and operation of VHF repeater stations within his area. Upon request, provide him/her with a copy of VHF repeater station schematic drawings, design details, and related information (including the latitude and longitude of station location, pattern of station coverage, and the date of the station's approval for operation).

h. Effect agreements with owners of private equipment, as required, to assure continued system operations.

F230. STATE DIRECTOR

The state director shall:

a. Provide control and supervision for the installation and operation of VHF repeater stations within his/her state, as directed by the area director.

b. Select and appoint a member as state VHF Repeater System Coordinator per Chapter 2, who shall act as principal assistant and advisor on VHF repeater system matters.

c. Determine the need for and provide the director with recommendations and necessary station drawings, design details, expected area of coverage, site location, and the name of appointed station engineer of proposed repeater stations prior to activation for approval.

d. Appoint a station engineer to each repeater station within his state.

e. Keep the director advised on the installation and operation of VHF repeater stations and recommend changes for expansion or improvements thereto.

F240. STATION ENGINEER

The station engineer shall:

a. Provide local control, supervision, and coordination for the installation and operation of the VHF repeater station to which assigned, as directed by the state director.

b. Perform periodic preventive maintenance and repair of station equipment to ensure continuous operation and conformity to the specifications and operating guidelines of this annex.

c. Maintain station records indicating times the station is down for repairs or maintenance and a summary of the work performed. Records should include performance measurements made during periodic alignment or calibration of station equipment.

d. Recommend changes for expansion and/or improvements of the repeater.

e. Make monthly frequency and activity usage reports to applicable authority as required.

f. Advise the state director periodically on the operation and condition of the VHF repeater station as determined from preventive maintenance checks and day to day operations.

F300. VHF REPEATER STATION LOCATION

a. In acquiring a site for a MARS VHF repeater station, no one is authorized to enter into an agreement, written or oral, that would commit the U.S. Government unless they have been so authorized by proper authority. All agreements between Naval authorities and parties concerned must be coordinated by the MARS area director.

b. VHF repeater stations shall be located on U.S. Navy, Marine Corps, or other U.S. Government property, whenever possible, to provide an effective system capable of telecommunication support for Navy disaster control operations.

c. Location consideration shall be based on the following:

- (1) Elevation compared to the surrounding terrain.
- (2) Availability of electrical power.
- (3) Accessibility to MARS members.
- (4) Security against unauthorized persons.
- (5) Security precautions must be effected to preclude unauthorized access, especially by minors.
- (6) Adequate airspace clearance availability (preferably without the requirement for tower lights).

F400. EQUIPMENT INSTALLATION REQUIREMENTS

a. VHF repeater stations as referred to in this annex may consist of either or both common VHF repeater equipment and linking system equipment and their associated control and interface equipment. Station installation must conform to all applicable local codes, ordinances, regulations, and to specifications herein. Any deviation from the specifications herein must have prior approval from Chief, NAVMARCORMARS. One of the major concerns shall be that of safety of life and property.

b. When access to a repeater station is not available within a reasonable length of time, a means to remotely control the

equipment is required. The remote control shall include provisions for selective control of the repeater system operations. As a minimum, provisions for turning the equipment ON or OFF shall be provided. All remote control functions shall be under the control of the station engineer and at least one alternate control station. Remote control may be provided by wire, radio, automatic timers or devices and/or combinations of all of these methods.

c. Repeater station equipment shall consist of government owned equipment, except when such equipment is not immediately available. Privately owned equipment which meets all the specifications herein may be substituted until such time as government owned equipment is available upon written agreement with the owner.

d. Repeater station radio equipment shall be housed in metal enclosures adequately ventilated and properly fused. In the event the station radio equipment is accessible to unauthorized persons when unattended, the metal enclosures shall be locked.

e. A means for automatic selection of alternate emergency power sources shall be provided whenever possible to ensure continued operation in the event of primary commercial power failure.

f. Provisions shall be made to preclude spurious emissions from activating the VHF repeater. Construction and appropriate engineering practices shall be employed to preclude receiver desensitization, adjacent channel interference or overload, and continuous or unintentional transmissions. These practices may include, but are not limited to, isolation, shielding, filters, control and signaling techniques.

g. When a repeater station is linked with other repeaters, provisions shall be made to preclude activation of the linked station(s) without a specific "call up" when required.

h. VHF repeater station antennas shall normally be vertically polarized and omni-directional. Link antennas shall normally be directional beam antennas. See article F900 for additional equipment and antenna specifications.

i. No restrictions shall be made that would limit transmission access to the VHF repeater station by any MARS member, Navy or Marine Corps activity having compatible VHF capability, except as provided for in this annex. When provisions

of the subparagraphs above concerning control and signaling techniques are employed, the details shall be widely disseminated.

j. The repeater station receiver sensitivity, transmitter power output, and/or antenna gains and patterns shall be adjusted to ensure the balanced operation of the station. The repeater station should be accessible by a properly aligned and operated mobile or remote fixed station whenever it can be received by the remote station at a level required for normal communications.

F500. STATION DESIGNATOR

A station designator shall be assigned to each operational repeater station which shall be derived as follows:

a. The first numeral of the designator will denote the MARS region in which the station is located.

b. The second letter, as assigned by the MARS director, similar to that of a net designator, will indicate the state in which the station is located.

c. The third numeral denotes the number and order of activation of the repeater stations within the MARS region.

d. The fourth letter, when used, will indicate the repeater stations linked together in a group. When groups of repeaters are linked together, the letter of the earlier group shall be assigned.

Example: 5 repeater stations operational in three states within the Fourth MARS region:

4G1
4H2
4I3
4H4
4G5

Repeater stations 2 and 4 are later linked:

4H2A
4H4A

Repeater stations 1 and 5 are later linked:

4G1B
4G5B

Repeater stations in groups A and B are later linked:

4G1A
4H2A
4H4A
4G5A

e. The fifth letter "X", when used, will indicate inter-region VHF repeater stations linkage:

Example: A repeater station in MARS Region Two, designated as 2F1, linked to a repeater station in MARS Region Three designated as 3M1B:

2F1AX
3M1BX

F600. LINKS

a. The VHF repeater system is intended to provide an effective and reliable communications medium for local geographical areas. It is not intended to provide intra-area or transcontinental inter-area communications. The networks established in other sections of this publication provide for the long distance communications requirements of MARS. The VHF repeater is considered one of the assets by which the state director can effectively meet the requirements of the emergency communication charter.

b. At the request of the state director and upon the approval of the area director, two or more repeaters within the state may be linked to extend the effective range of a common VHF frequency network. Linked repeaters shall normally be confined, insofar as possible, to the geographical limits of each MARS state to preclude over-burdening the repeater facilities and to ensure the network is responsive to the needs of the state directors and their staff. When required for specific emergency networks only, links may be extended into adjacent states upon agreement of each state director. Inter-state links shall not be extended beyond one repeater in each state except when required to relay over or around geographical barriers.

c. Each state with a common linked repeater network will provide a station or stations with multimode HF frequency capabilities to act as the emergency relay station into or out of the VHF network. Links extended into adjacent states should be only for the purposes of providing an alternate relay station which is capable of access to region emergency networks.

d. Links between adjacent repeaters should only be activated when required to extend local communications to the adjacent repeater. The activation of the link shall be accomplished from any repeater within the link. When links are extended through three or more repeaters, it is considered advantageous to be able to selectively activate the repeaters so that local networks will not be disrupted while the link is extended through their state.

e. Activation of the repeater links will require positive activation of a control circuit other than carrier operated relays. Once the circuit is activated, carrier operated relays (COR's) may be used to maintain the circuit for a specified time. If a repeater link consists of three (3) or more repeaters, automatic fail safe timers will be incorporated to ensure that a single failure does not force lock the link in the enabled mode. Timers will be adjusted to disconnect the link at not less than thirty (30) minute intervals. Reset of the link timers may be accomplished at intervals necessary when continuous operations are desired.

f. Signaling for link control circuits will be consistent with the requirements of this annex.

F700. VHF REPEATER SYSTEM OPERATIONS

F710. GENERAL OPERATIONS

a. Whenever the repeater station or link network is to be rendered inoperable more than 24 hours because of a forthcoming maintenance period or is inoperable because of malfunction, the station engineer shall notify the state director or the appointed assistant, area and region director, and MARS members or activities having access, providing the reason and the estimated downtime.

b. Transmission through the repeater station shall be limited to that time necessary to convey the message. Users should be alert for other stations attempting to break the repeater with higher precedence traffic. A weak beat note will be heard from

the heterodyne of two signals attempting to access the repeater station at the same time.

c. Repeater stations shall normally be available for utilization on a continuous basis, 24 hours a day. MARS members are encouraged to monitor the repeater station whenever possible for emergencies. The period between 2300 to 0600 local time should be reserved for emergencies and/or urgent communications so as to not disturb unnecessarily members who monitor on a continuous basis.

d. Before any transmission is made for access to the repeater station, the VHF repeater output frequency shall be monitored to preclude interference to transmissions that may be in progress.

F720. EMERGENCY COMMUNICATIONS OPERATIONS

When the repeater is used for an emergency network, the first station initiating the repeater operations shall act as net control station until relieved by higher authority.

F730. VHF REPEATER SYSTEM SIGNALING AND CONTROL

Signaling for control and special operation of VHF repeater systems will be based on the Bell Telephone Laboratories, Inc., Touch Tone frequency standards. Table 1 details the frequencies and the digit decoded. It is intended that all signaling be accomplished from this standard using single, dual, or repeated transmissions of these frequencies.

TABLE 1

Bell Telephone Laboratories, Inc., Touch Tone Frequencies

<u>Digit</u>	<u>Frequency (Hz)</u>
1	1209, 697
2	1336, 697
3	1477, 697
4	1209, 770
5	1336, 770
6	1477, 770
7	1209, 852
8	1336, 852
9	1477, 852
0	1336, 941
*	1209, 941
#	1477, 941

a. Frequency tolerance for signaling purposes shall be ± 1 Hz below 1,000 Hz and ± 2 Hz above 1,000 Hz.

b. The use of the frequencies in Table 1 does not preclude the use of the "Whistle Up" method of repeater control. Demodulators for "Whistle Up" control will be centered on one of the frequencies in Table 1.

c. The requirements for tone control activation of local repeaters will be incorporated only when it is necessary to control the activation due to interference from adjacent repeaters or other VHF transmitters. When incorporated, the requirements will be widely disseminated. Subaudible analog tone or digital squelch (CTCSS or DCS) may be utilized to eliminate interference between systems if requested by the state director and authorized by the area and region directors.

d. Audible signaling sources modulation shall not be less than 40% or more than 70% of maximum system deviation. All audible tones shall be sent with flat audio characteristics rather than being pre-emphasized.

e. Signaling and control signal sources shall have less than 10% total harmonic distortion plus noise.

f. Signaling and control transmission time shall be less than 30 seconds in 60 seconds per function.

g. A specific signal or control function will be required to activate link circuits and each repeater in the link chain.

h. Signal and control demodulators will be designed so that normal voice and Audio Frequency Shift Keying (AFSK), VHF packet and MT63 tones will not activate the control function. In this regard, the following tones are suggested for AFSK operations:

- (1) Wide Shift - 2125 - 2975 - mark low
- (2) Narrow Shift - 2125 - 2295 - mark low
- (3) VHF Packet - 1200 - 2200

F740. VHF REPEATER SYSTEM CHANGES AND EXPANSION

Repeater station design and fabrication should allow for additional circuits and equipment, and in such a way that modifications be held to a minimum with a minimum of downtime.

The concept of modular circuit construction with plug-in circuit boards provides the easiest method of modification.

F750. VHF REPEATER SYSTEM AUTOPATCH OPERATIONS

The capabilities of interface connections between mobile and portable VHF equipment and the commercial telephone system are considered advantageous in an emergency. Autopatch users are cautioned that the same restrictions governing message criteria on HF MARS circuits apply to VHF repeater circuits. The establishment and use of autopatch systems for official MARS related purposes is encouraged. Coordination and approval by the area director is required.

F800. VHF REPEATER STATION FREQUENCY REQUIREMENTS

To enable MARS to meet the requirements to fulfill its mission in providing auxiliary communications during periods of emergency, especially Navy disaster control operations, it is essential that the VHF repeater system provide a means for maximum mobility. In order that this may be accomplished, the use of common frequencies and modes in all VHF repeater stations is necessary whenever possible. VHF repeater frequencies shall be assigned by Chief, NAVMARCORMARS. The link and control frequencies shall be assigned by the MARS area director. When such frequencies are assigned, they shall not be used for other MARS activities. However, if requested by the state director and authorized by the area and region directors, stations may utilize the repeater OUTPUT frequency for direct station to station digital or voice communications on a secondary basis. The mode of operation of all VHF repeater system frequencies shall normally be narrowband FM (11K00F3E) and operated with 2.5 KHz deviation.

F810. VHF REPEATER MIGRATION TO NARROW BAND OPERATIONS

Existing repeater systems operating on wide (25 KHz) channels will be migrated to narrowband operation per a schedule developed by Chief, NAVMARCORMARS and the area and region director and their staffs.

F900. VHF REPEATER EQUIPMENT AND ANTENNAS

F910. VHF REPEATER SYSTEM EQUIPMENT SPECIFICATIONS

a. VHF repeaters and link stations operating with narrowband 11K00F3E modulation shall maintain transmit frequency stability of 300 Hz, 2 parts per million (PPM). Repeaters operating with wide

16K00F3E modulation prior to narrowbanding must maintain transmit frequency stability of 750 Hz, 5 PPM. Member stations must maintain a frequency stability of 750 Hz, 5 PPM on all fixed, mobile, or portable transmitters operating through a repeater.

b. Transmitter power output shall be the minimum necessary to effectively cover the area in which the repeater may be accessed.

c. Audio distortion through the repeater shall be less than 10% for 100% modulation and in no case discernible by ear.

d. Transmitters shall have a minimum duty cycle capability of 30 minutes on, 5 minutes off or Continuous Commercial Service (CCS) ratings.

e. Transmitters shall remain keyed for at least one (1) second and not more than ten (10) seconds after the input channel has ceased operation.

f. Receiver bandwidth shall be not more than 150% of the peak-to-peak 100% modulation bandwidth measured at the 6 db down points.

g. Receiver carrier operated relay delay time shall be less than 0.1 second opening and 0.6 second closing with 100 microvolt signal at nominal squelch control setting.

h. Specifications not otherwise stated shall be those normally accepted in commercial communications practices.

i. Subaudible CTCSS or DCS code systems shall operate with a deviation of at least 200 Hz but not exceeding 500 Hz. The same tone or digital code utilized on the repeater or link receiver shall be sent by the repeater or link transmitter whenever it is keyed. If an automatic station identifier is used, the squelch code shall be transmitted during the ID interval.

F920. VHF REPEATER SYSTEM ANTENNA REQUIREMENTS

a. Antennas and mounts shall meet applicable state and federal codes, laws, and regulations regarding structures and antennas.

b. Antenna and support wind loading factor shall be 100 MPH.

c. Antenna feed line shall be of coaxial type.

d. Antenna should exhibit a voltage standing wave ratio of 2:1 or less at operating frequency.

F930. VHF REPEATER SYSTEM ANTENNA SPECIFICATIONS

a. Antennas shall have vertical polarization.

b. Antennas shall be omnidirectional except when circumstances warrant, in which case, a cardioid or other appropriate directional pattern antenna may be used. (i.e., when service area is concentrated in one or two quadrants.)

c. Antennas shall be gain types whenever practical.

d. Antenna shall have a minimum power rating of twice the transmitter rated power output.

F940. VHF REPEATER SYSTEM LINK FREQUENCY ANTENNA

a. Antennas shall be horizontally polarized except where vertical polarization would result in attenuation of interference, extend range, or improve reliability.

b. Antenna shall be directional with minimum attenuation of radiation in the horizontal plane of:

(1) 9 db at 90° and 270°

(2) 12 db at 180°

Additional directional attenuation may be required in the station authorization to reduce likelihood of interference.

c. Antenna type shall be governed by frequency band and availability consistent with specifications.

d. Antenna shall have a minimum power rating of twice the transmitter rated power output.

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