CHAPTER 6

INTERSITE COMMUNICATIONS LINKS

6.1 GENERAL

Communications channels are required to link the communications center with the receiver building, transmitter building and any other locations that may be serviced by the communications center. The intersite communication links provide the necessary channels between locations. All information carried over the links is in an unclassified form and the primary flow is from the communications center to the transmitter building and from the receiver building to the communications center. In addition, two-way traffic is carried between the locations for control and coordination of the communications resources.

Information is carried over the links in standard 4-kHz bandwidth audio circuits when the distance between locations exceeds two miles or when the transmission of DC signals is not reliable due to high RF radiation or background noise. DC signals are transmitted as VFCT tone groupings on 4-kHz audio circuits. The 4-kHz audio circuits may be provided by a local telephone company or by a Navy-owned microwave system. Except at overseas locations on foreign soil a military-owned telephone system must be used rather than the local telephone company. The DCS transmission standards for the 4-kHz audio circuit are contained in DCAC 330-175-1.

6.2 LINK SELECTION

The link system to be used between sites is determined by cost study compared with a careful evaluation of the requirements. A combination of DC and audio circuits may be satisfactory and is often used. The cost study may conclude that a telephone company service is preferred, but communications security requirements or space availability may dictate the selection of another system. For example, a separate room or building for the telephone company equipment is always required; this could be the controlling factor in selecting the type of link to use.

6.3 LINK INTERFACE

The main distribution frame is the point of interface between the link transmission system (microwave, telephone or DC) and the other communications facilities in the building. Each individual send and receive channel of the link system is terminated on the main distribution frame from which the channels are routed for further processing or distribution.

6.4 NAVY-OWNED MICROWAVE INTERSITE LINKS

Navy-owned microwave intersite links are wideband, line-of-sight, transmission systems. Frequency division multiplexing methods are used for the simultaneous transmission of information on 4-kHz bandwidth channels in either or both directions.

Microwave systems currently in use operate in the frequency bands of 1700 to 1850 MHz, 2200 to 2300 MHz, and 7125 to 8400 MHz and can accommodate up to 600 4-kHz channels. To ensure link reliability, most Navy installations have two continuously radiating transmitters and two operating receivers at each terminal. At a given microwave terminal either of the operating transmitters is fully capable of maintaining circuit continuity to the distant terminal, and either receiver is fully capable of receiving all information from the distant terminal. Further information is contained in NAVELEX 0101, 112 - Line-Of-Sight Microwave and Tropospheric Scatter Communications Systems.

6.4.1 Microwave Propagation

Microwave RF energy travels in a direct path from the transmitting antenna to the receiving antenna; however it can be reflected from the surface of the earth or any other reflecting surface. The reflected energy often arrives out of phase with respect to the direct wave and may cause cancellation and serious fading of the received signal. Earth-reflected energy is particularly bothersome at operating frequencies between 1000 and 3000 MHz. Above 3000 MHz earth reflections become less serious since the small irregularities of the earth's surface, such as rocks, become an appreciable part of the wavelength and scatter the energy instead of reflecting it. Because of this scattering, a strong reflected signal does not arrive at the receiving atnenna. At frequencies above 10, 000 MHz raindrops or snowflakes can cause high attenuation of the signal since their diameters may be one-half of a wavelength or more at the frequency of the transmitted RF energy. The drops or flakes thus short-circuit the electric field, and the energy is dissipated as heat. A water surface between transmitting and receiving antennas forms a poor microwave path because the smooth surface is an excellent reflector. Rough terrain makes a better microwave path than does a smooth surface, since the surface irregularities refract and scatter the reflected energy. A high-low antenna siting technique is one method of causing the refracted energy to be reflected away from the receiving antenna when propagation is over water or smooth earth. Figure 6-1 illustrates this technique for both water and smooth earth.

When a direct line of sight can not be selected, it is possible to use passive reflectors or back-to-back parabolas to alter the direction of transmission. A change of transmissions direction might be dictated to avoid interference with other services or to avoid an obstacle in the path between stations. A plane reflector can be used when the stations are located so that the signal will "bounce" off the reflector onto the receiving antenna. Plane reflectors arranged as shown in figure 6-2, may be used to provide a double "bounce," but plane reflectors may not suffice when a very high ridge intercepts the beam. In this latter case, back-to-back parabolic antennas interconnected by a short length of waveguide or coaxial cable can be used. One antenna faces each station.

6.4.2 Path Selection

Due to the fact that microwave energy propagates like light energy, a clear line-of-sight path must exist between the transmitting and receiving antennas of a microwave system. Although the problem appears simple, it must be appreciated that over a path of 20 to 30 miles, it is difficult for an observer to determine the relative elevations along the path. Several methods are available for obtaining a path profile, one way being to consult topographic maps published by the United States Department of the Interior Geological Survey. State indexes and a folder describing topographic maps are furnished free on request. Maps may be ordered by mail as follows:

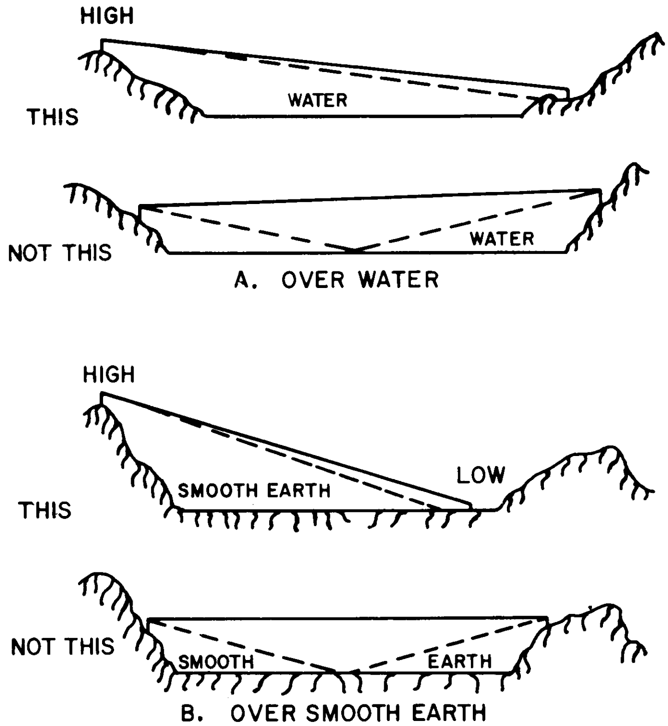

Figure 6-1. High-Low Antenna Siting Technique

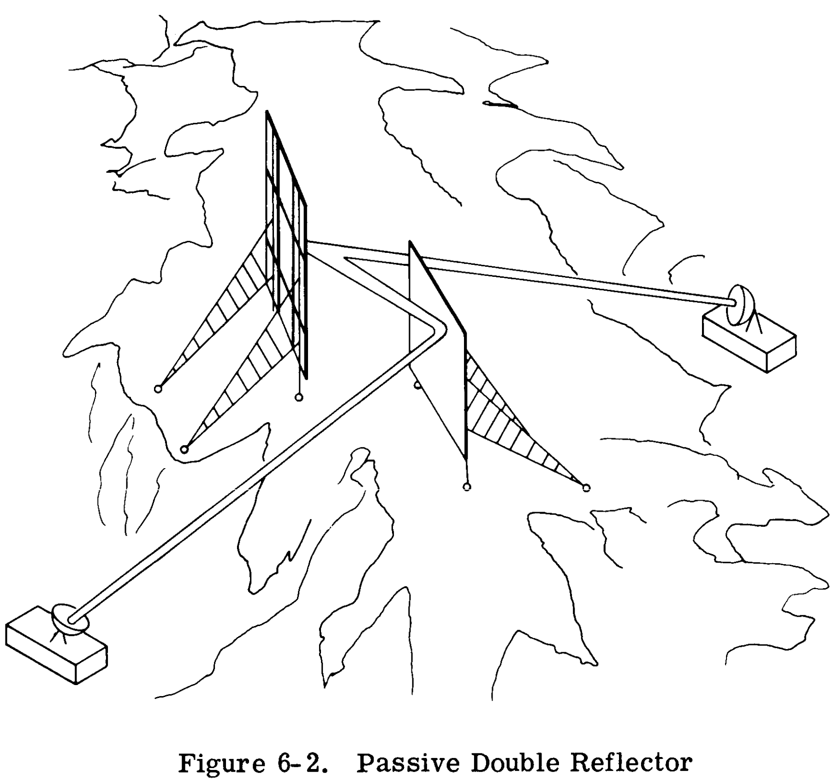

Figure 6-2. Passive Double Reflector

a. For maps of areas west of the Mississippi River, address the Geological Survey, Distribution Section, Federal Center, Denver, Colorado.

b. For maps of areas east of the Mississippi River, address the Geological Survey, Distribution Section, Washington, D. C.

c. For maps of Alaska, address the Geological Survey, 520 Illinois Street, Fairbanks, Alaska.

Further path study will be required because the topographic maps do not show tall buildings or heavy timber growth or other factors that might influence the propagation of microwave energy. A path survey may also disclose that a large flat area shown on the topographic map becomes flooded during spring rains, creating a large water surface along the transmission path. Other methods of obtaining a path profile include surveying with normal surveying instruments, or plotting the readings of a radio altimeter from a helicopter. (An aneroid altimeter is used to maintain the helicopter at a fixed altitude while it is being flown over the proposed path.) One relatively easy test technique is to transmit along the desired path and suspend receiving equipment below a helicopter in the proposed receiving antenna location. The height of the tower required to support the receiving antenna can be determined by locating the strongest signal. A detailed procedure for selecting the most desirable microwave propagation path and determining specific antenna height is the subject of a handbook planned for future publication.

6.4.3 Multiplexing Equipment

Frequency division multiplexing is used with the microwave transmission links. The multiplex equipment combines 4-kHz voice-frequency channels into discrete portions of the microwave link baseband. The current standard multiplex set is the AN/UCC-4 (V) which is similar to the AN/FCC-17, the previous standard. The distinctive difference between the sets is the method of channel modulation. Multiplexer set AN/UCC-4 (V) has a lower-sideband modulation plan requiring 12 channel-carrier frequencies; each channel uses a different carrier. The lower sideband is selected from the channel modulator. See figure 6-3. Multiplexer set AN/FCC-17 has a twin-channel modulation plan requiring only six channel-carrier frequencies; two adjacent channels use the same carrier. The lower sideband is selected for one channel and the upper sideband for the other. See figure 6-4. Another important difference between the two types of multiplexer sets is the frequency and transmission level of the group pilot: the AN/UCC-4(V) pilot is 104.08 kHz at –20 dBm0, whereas the AN/FCC-17 pilot is 64 kHz at –16 dBm0.

The AN/UCC-4(V) is adaptable to station expansion since the equipment capabilities and its power supply capacity may be expanded by adding modules to the basic system. The basic electronic equipment supports from 12 to 60 communications channels and occupies four standard equipment racks. For each 60-channel expansion, two additional racks of equipment are required. The system can be expanded in this manner to reach a total system capacity of 600 channels. A typical floor plan of a 360-channel set is shown in figure 6-5.

The following installation requirements have been established for the AN/UCC-4(V) set.

a. The batteries are to be installed in a separate room from all other equipment.

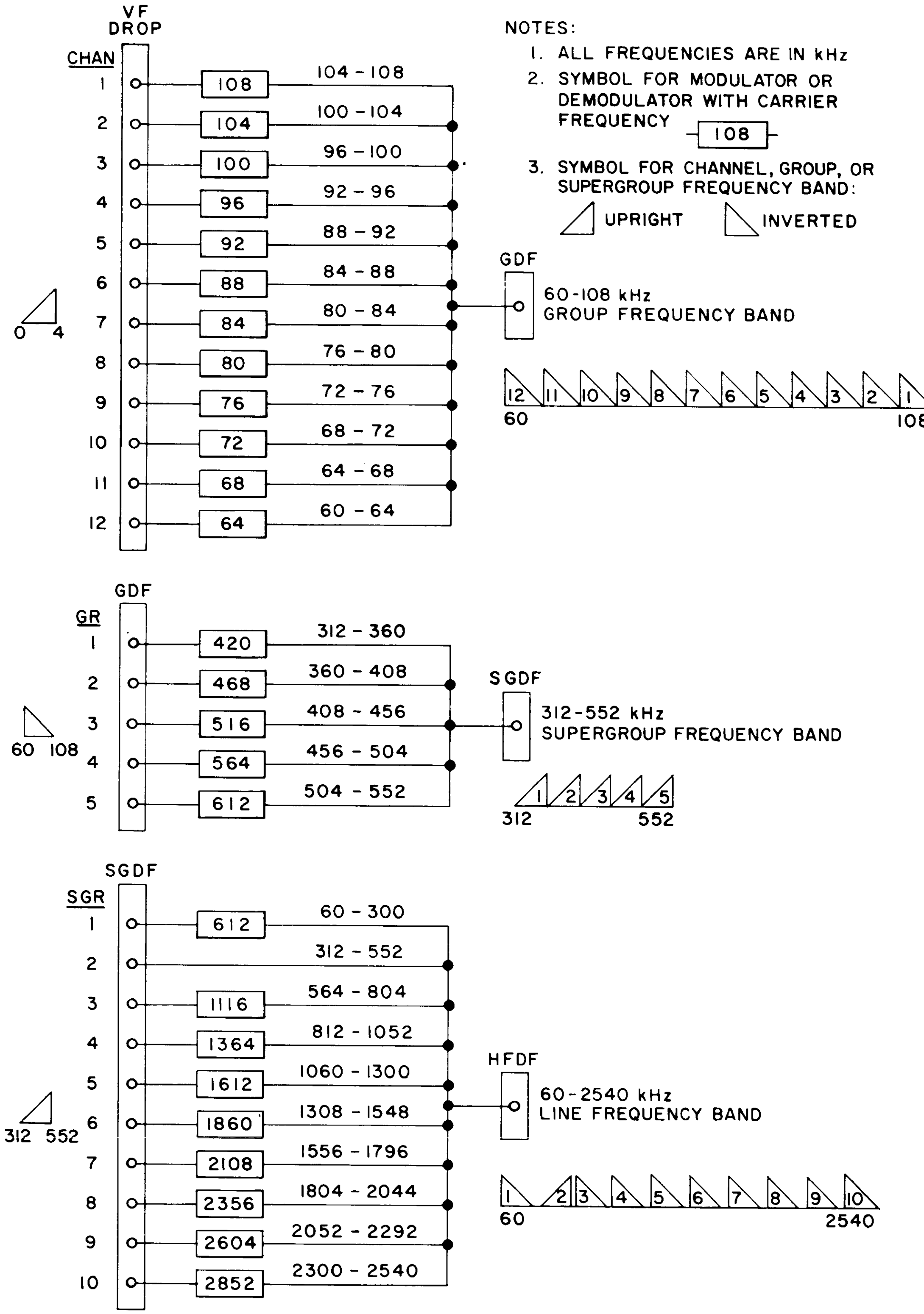

Figure 6-3. AN/UCC-4(V) Frequency Translation Plan

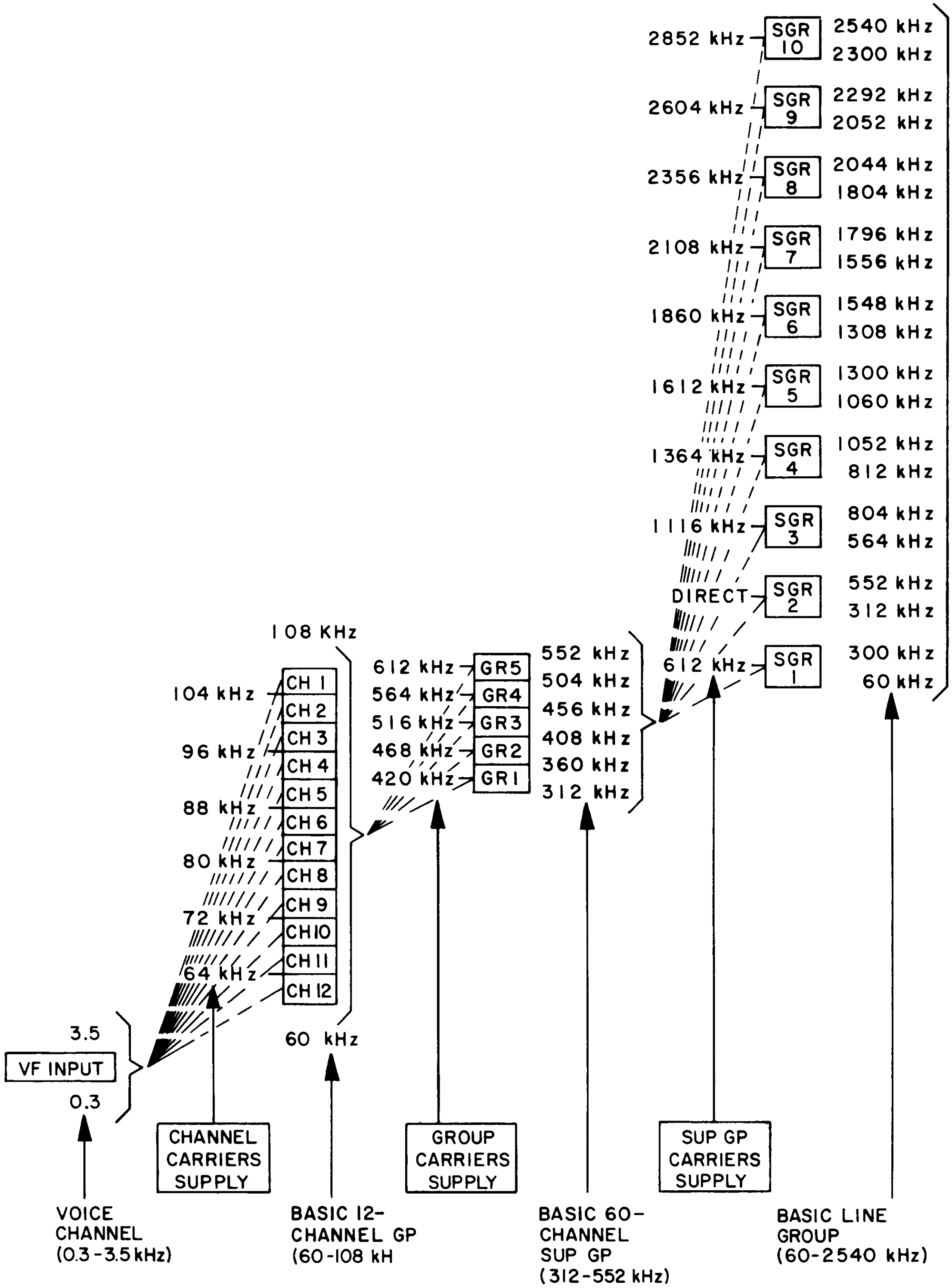

Figure 6-4. AN/FCC-17 Frequency Translation Plan

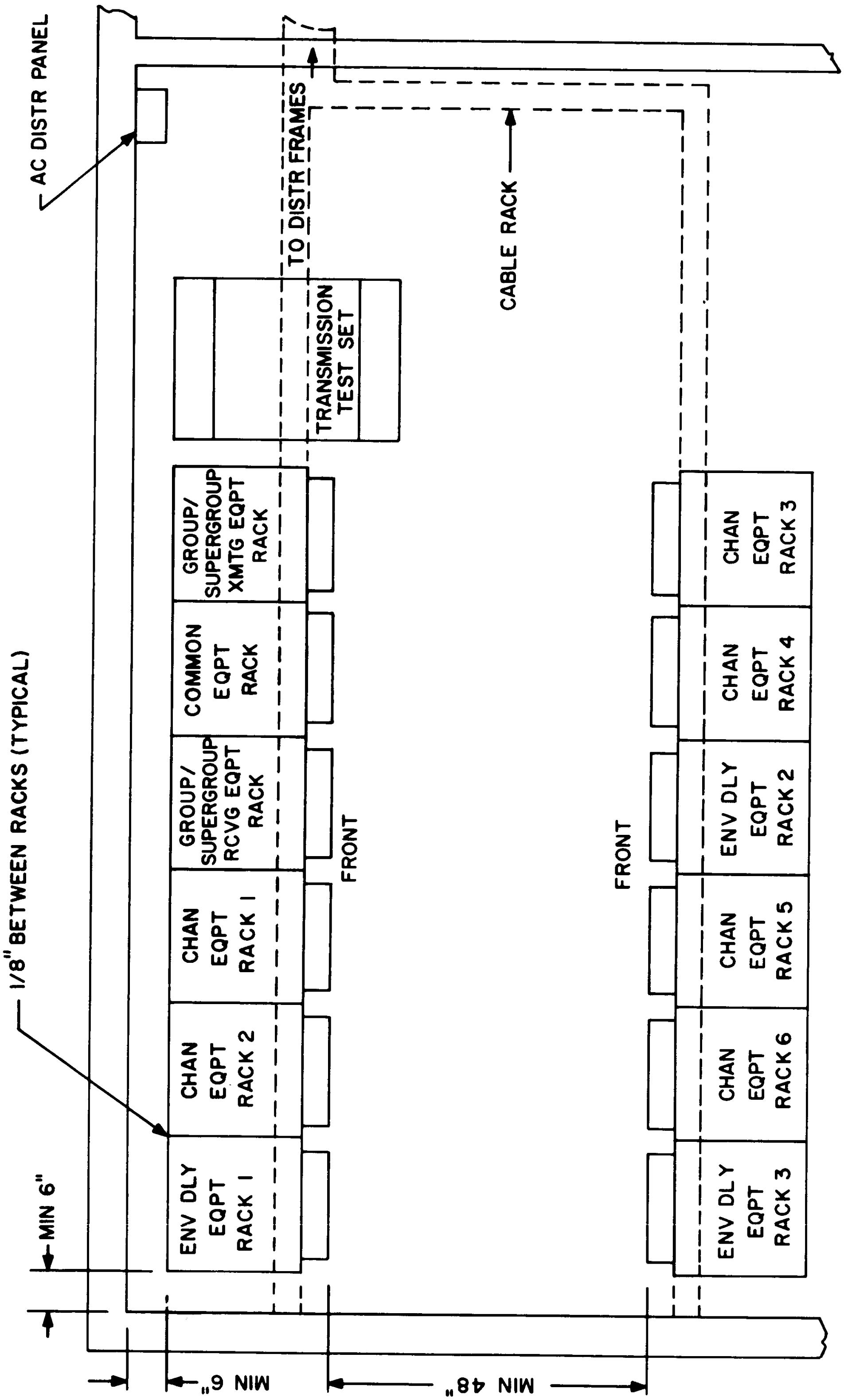

Figure 6-5. AN/UCC-4(V) Typical Floor Plan

b. The battery room is to be supplied with its own ventilation intake and exhaust ports to the outside air.

c. The central ventilation system supplying air to and exhausting air from the building may be used to supply air to the battery room for exhausting to the outside air.

d. A ceiling height of 10 feet and a floor space of 10 square feet should be programmed for each rack of equipment to ensure a sufficient maintenance and operational area.

> NOTE: Most racks measure 90 x 23-1/4 x 20-1/8 inches and require a minimum height clearance of 8 feet and a front clearance of 48 inches.

e. The room temperature should be maintained at 77° F (± 18°) and the relative humidity should not exceed 80%.

f. The set may require RF shielding if it is located near high power radio transmitting equipment. However, the presence of radiated electromagnetic fields up to the following limits are permissible.

(1) 14 kHz to 2.6 MHz: .... 0.1 volt/meter

(2) 2.6 MHz to 100 MHz: .... 0.3 volt/meter

(3) 100 MHz to 10,000 MHz: .... 1.0 volt/meter

6.4.4 Power Supply

Present day microwave systems used by shore stations are furnished a 48-Volt DC rectifier charger unit with a floating lead-calcium battery plant connected across the power leads. The batteries when fully charged and at a temperature of 77°F will carry the system for 8 hours under full load during AC power failure and the charger unit will restore the batteries to full charge within 24 hours. At lower battery room temperatures, the batteries will carry the system at full load for less than 8 hours, and correspondingly more than 24 hours will be required to restore the batteries to full charge. During normal operation the batteries float on the line with the charger unit serving as the primary power source.