CHAPTER 3

TECHNICAL GUIDANCE

3.1 INTRODUCTION

All Phase I IDSCS earth terminals and those proposed for the Phase II DSCS are either transportable or mobile terminals. The Department of Defense, with the concurrence of the Joint Chiefs of Staff, has established the policy that earth terminals will not be installed permanently in any overseas location and will be maintained in such a condition that they may be relocated readily from such overseas location. This policy precludes removal of terminal equipment from the vans for installation in buildings except within the territorial limits of the United States. If the equipments are to be removed from the transportable or mobile vehicles (initially provided) and installed permanently in buildings, the applicable shore station installation criteria apply.

The technical guidance of this chapter applies to Navy earth-terminal installations in which the configuration of the van-mounted equipment must be maintained intact. In view of the above, and since these terminals are designed to be self-sufficient, the technical installation criteria are not very extensive.

As a matter of Department of the Navy policy, satellite earth terminals will always be located near a permanently established naval communication station and will be installed on a semipermanent basis. Although equipments will not be removed from the vans, permanent buildings will be used to house associated peripheral equipment. Concrete foundations will be constructed to support the antenna pedestal and radome, hardstands will be installed for placement of the vans, and base or commercial power will be provided.

3.2 SITE SELECTION CRITERIA

Site selection criteria for installation of earth terminals are contained in the effective editions of DCA circular 800-2000.1 — "Criteria for Earth Station Site Selection of the Defense Satellite Communications Systems (DSCS)" and DCA circular C810-2300.2 — "Inital Defense Communications Satellite Project Earth Station/Defense Communications Systems Interface and Engineering Criteria." The DCA criteria of these publications are quite restrictive because the criteria were established to enable tracking satellites in many types of orbits. The criteria in this handbook are much less restrictive because these criteria were established for tracking only near synchronous and synchronous equatorial satellites.

3.2.1 Siting Requirements

a. General Requirements. Primary considerations in selecting a site for an earth terminal are the orbit of the satellite and the apparent path of the satellite as viewed from the earth terminal. The Phase I IDSCS satellites are in near synchronous equatorial orbits and always appear to move across the sky in the same path from the western to the eastern horizon. The Phase II DSCS satellites will be in synchronous equatorial orbits and will appear to be stationary in the sky (although the satellites may be repositioned from time to time). The apparent paths of the Phase I satellites are determined by the latitude of the earth terminal. With the latitude of the proposed site known, figure 3-1 can be used to determine the approximate paths of Phase I satellites. Although the Phase II satellites will be synchronous (apparently stationary), they will be capable of being repositioned longitudinally. Therefore sites proposed for Phase II operations should have clear horizons for all expected satellite positions (as shown in figure 3-1 for the corresponding site latitude). Once the sky area to be tracked has been determined various possible sites can be considered.

Factors which should be considered in selecting a site for an earth terminal location include:

(1) Fairly flat terrain for minimum site preparation.

(2) Obstruction-clear horizon profile within the sector of satellite visibility, taking into account antenna elevation.

(3) Sufficient area to accommodate the number of terminals and accompanying support facilities.

(4) Protection from radio frequency interference (RFI); conversely, RFI protection from earth terminal transmission for existing facilities.

(5) Proximity to a naval communications station facility. (The facilities of a naval communications station will be used by Navy-operated satellite earth terminals as a DCS entry point.)

(6) Provision for survivability, as applicable.

(7) Acceptable environmental conditions such as an area free of possible floods or slides and having good soil-bearing characteristics.

(8) Accessibility and logistic support.

Ideally, an earth terminal should be located in a relatively flat, saucer shaped area with a clear view of that part of the sky through which the satellites are expected to travel and with hills or other natural obstructions in the northward sectors (southward in the southern hemisphere). Horizon masking in the directions of satellite rise and set should not exceed 2.5° in order that the maximum sector of satellite visibility may be obtained with the Phase I satellites. Horizon masking in other sectors will provide protection from RFI, assuming that no RFI sources lie within the horizon of the terminal in the line of sight of the antenna. (Note that even a protected location can be exposed to RFI by some propagation modes; for example, scatter and diffraction.) It is necessary to survey proposed sites to determine if there are obstructions that will mask the satellite at any particular azimuth. (See subparagraph c below.)

b. Surveying Accuracy. Accurate determination of the geographic location of the selected earth terminal antenna site is required in order that accurate antenna pointing information may be computed. Whenever possible, third order surveying accuracy (one part in 5000) should be maintained to establish the azimuth and length of the base line, the elevation of the site, and reference markers. This degree of accuracy is not required for preliminary site selection but is required for any chosen operational site.

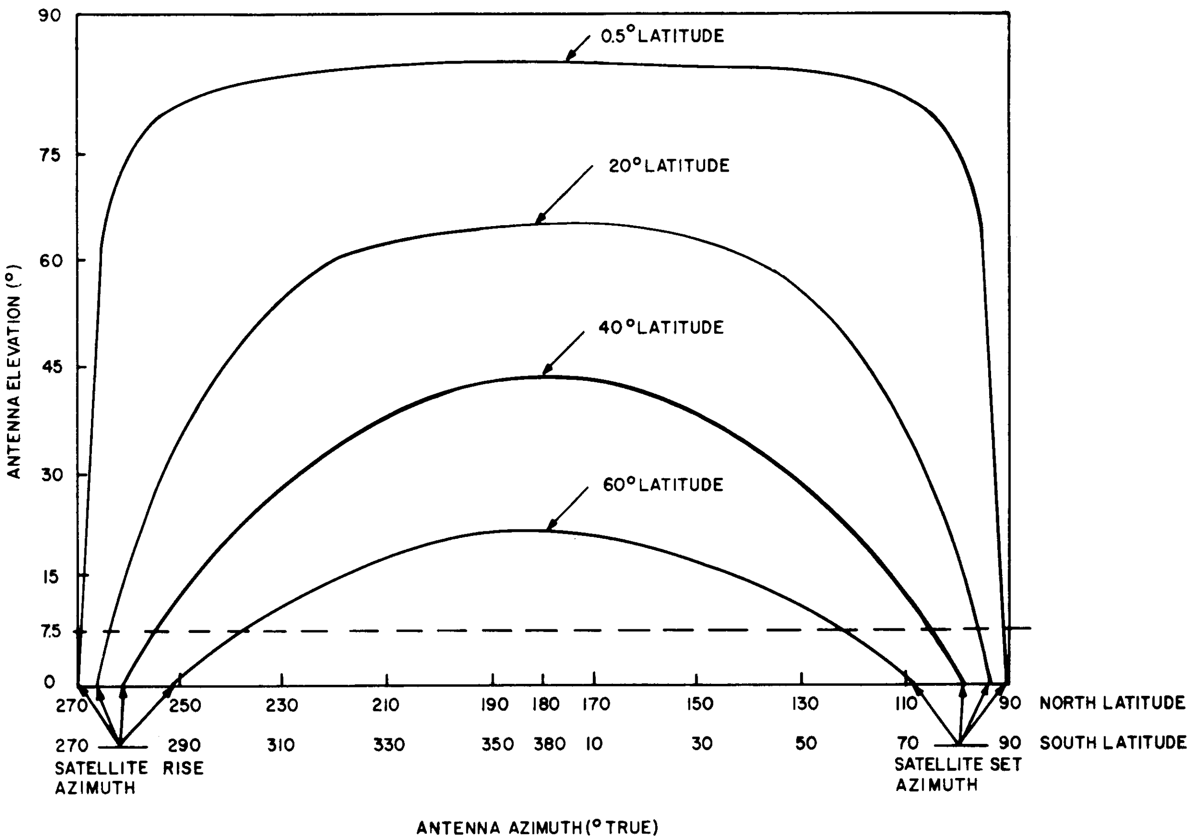


Figure 3-1. Antenna Elevation as a Function of Azimuth

c. Horizon Profile. In considering possible sites the horizon profile must be determined throughout the azimuth sector in which the satellites may appear. The earth terminal antenna beam path must have a clearance of at least 5° elevation above horizon obstructions throughout the earth terminal's sector of satellite visibility. Figure 3-1 shows antenna elevation at latitudes 0.5°, 20°, 40°, and 60° as a function of azimuth. For equatorial satellites this information may be used to determine the sector of visibility in which obstructions to the terminal-to-satellite radio path must be considered. The azimuths for equatorial satellite rise and set are shown with greater accuracy in figures 3-2 and 3-3 for site locations in northern latitudes and southern latitudes respectively. Depending on the latitude of Phase I IDSCS earth terminal sites, horizon profile clearances less than the prescribed 5° may be allowed at azimuths other than those of satellite rise and set.

d. Site Layout. For sites in the northern hemisphere, the earth terminal should be located on the south side of any building. Generators and any other auxiliary equipment should be sited to the north of the antenna. This layout should be reversed for sites in the southern hemisphere. The orbit of the satellite should be considered in laying out the site. Since there are no plans for satellites other than those in equatorial orbits, a multiple terminal site generally should have terminals placed in a north-south line; however, for terminals at the greater latitudes (approximately 40° or higher), terminals should be placed in an east-west line — this will prevent the screening of one terminal by another. A minimum separation of 350 feet between earth terminals should be maintained to reduce the possibility of radiation hazards and RFI. Locations for equipments within each earth terminal are limited by the lengths of interconnecting cable furnished with the terminal. Interconnect cables for the AN/TSC-54 are 50 feet long, for the AN/MSC-46 100 feet long with both equipments having longer power cables. (For semipermanent installations the power leads can exceed the length of the equipment power cable provided the proper size of wire for the distance and power frequency is used.) Input/output cables for connecting the operations vans to the Link Terminal Terminating Equipment (LTTE) are not supplied with the earth terminal equipments. See subparagraph 3.3.2 for further discussion of LTTE requirements. Figure 3-4 shows a typical multiple earth terminal site layout. Table 3-1 shows typical dimensions, applicable to figure 3-4, for the AN/MSC-46 and AN/TSC-54 earth terminals.

Table 3-1. Dimensions of a Typical Site Layout for 1, 2, and 3 Earth Terminals

EARTH TERMINALS	A* (ft)	B* (ft)	C* (ft)	D* (ft)	E (ft) *			F* (ft)
					1 TERM	2 TERM	3 TERM	
AN/MSC-46	225	350	100	100	325	675	1025	450
AN/TSC-54	225	350	100	50	325	675	1025	450

*See figure 3-4 for legend.

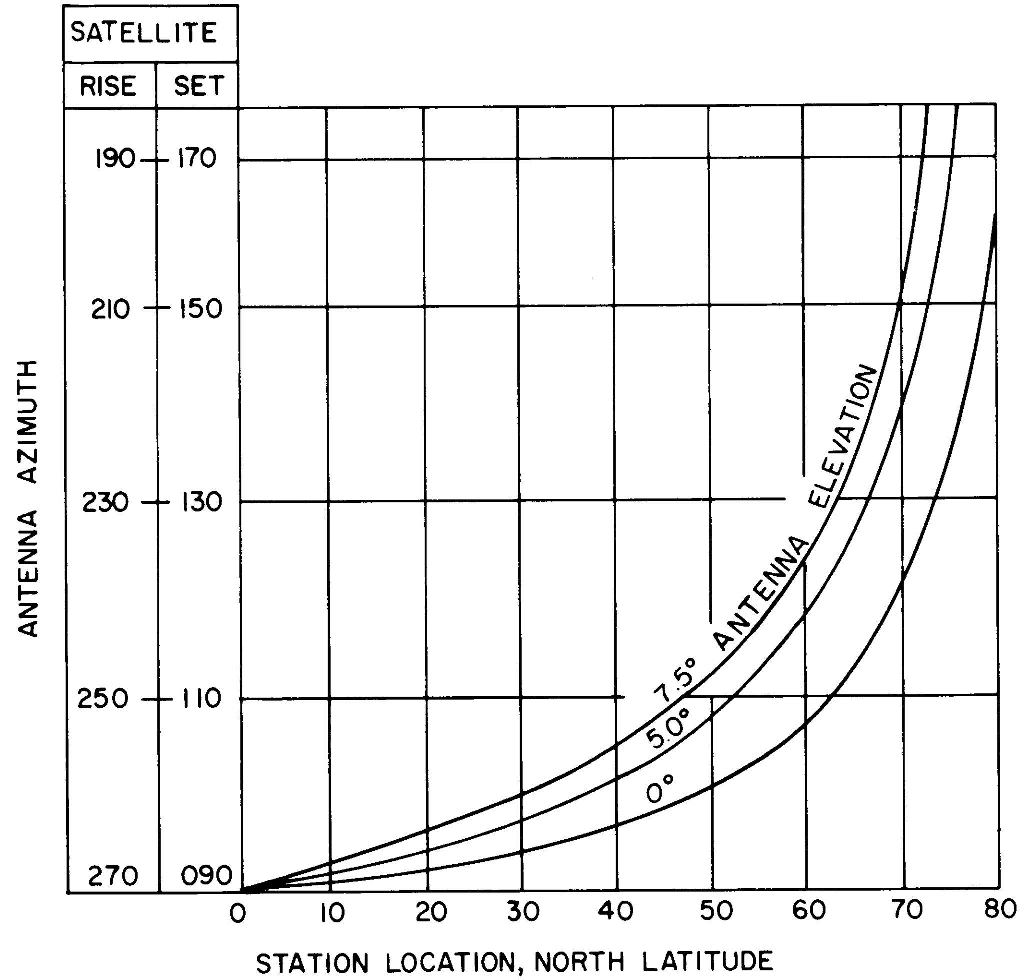


Figure 3-2. Rise and Set Azimuths - Northern Latitude

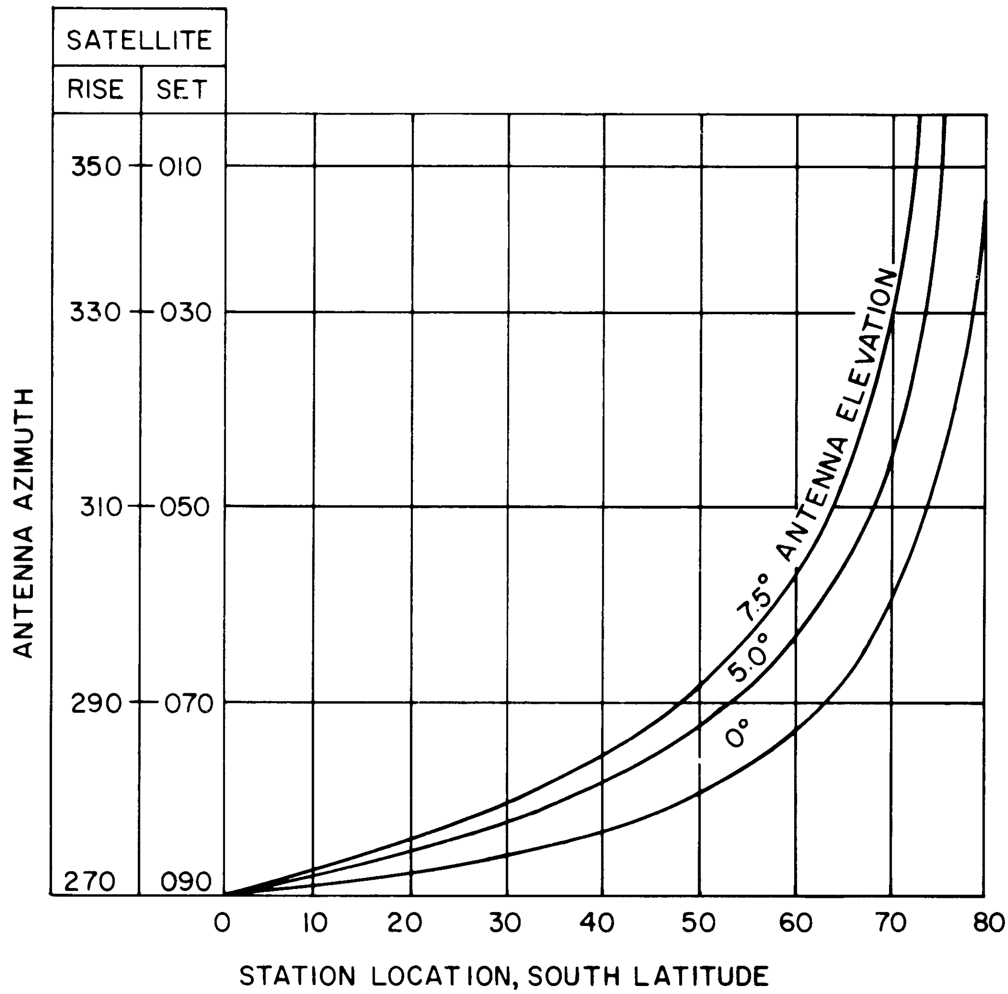


Figure 3-3. Rise and Set Azimuths - Southern Latitude

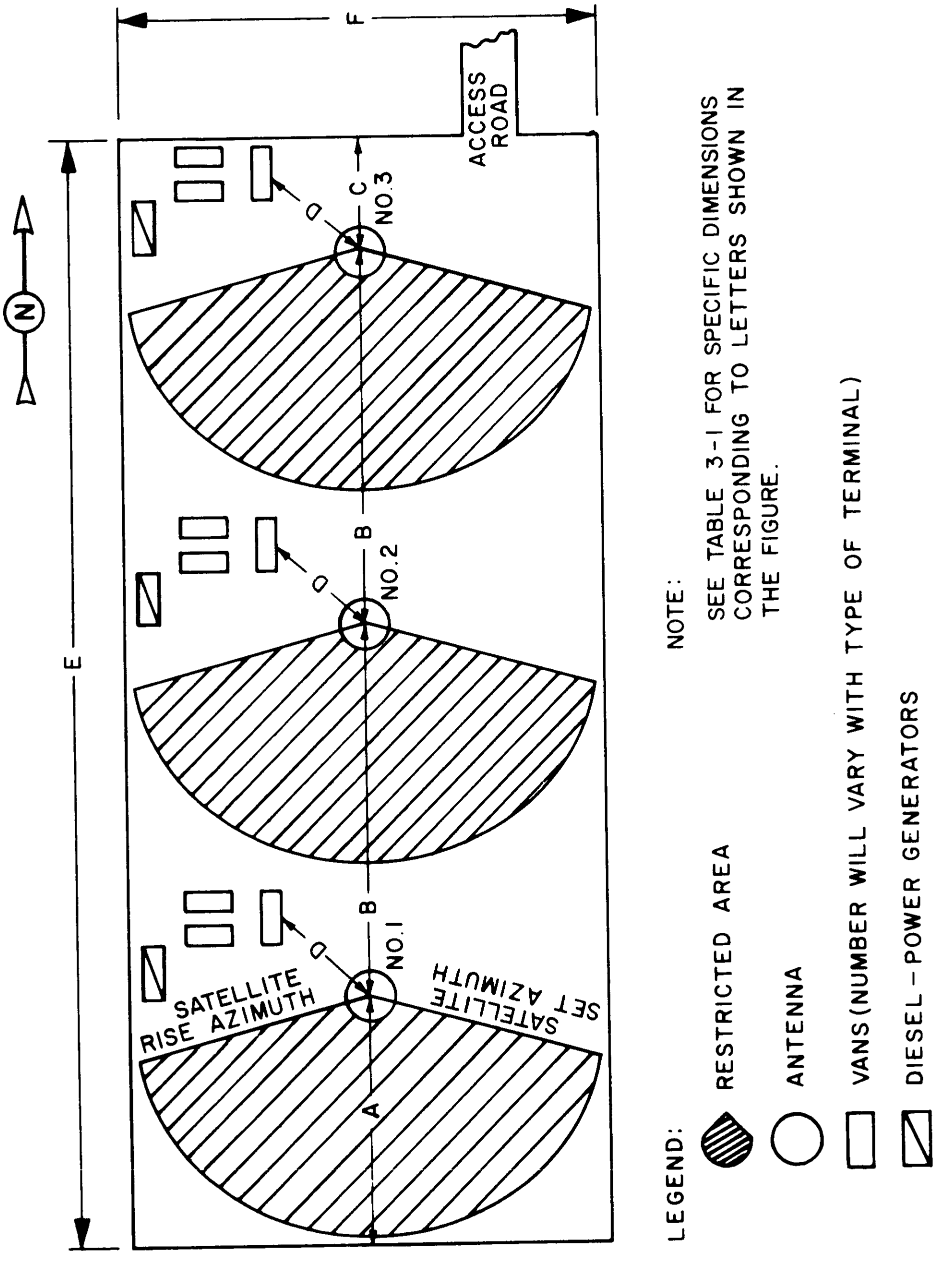


Figure 3-4. Typical Site Layout for Three Earth Terminals (Northern Hemisphere)

e. Map Requirements. In considering possible sites, a map of the general area showing specific information about the proposed site and general information about the geographic area will prove quite useful. Such a map should include access roads; arterial roads; populated areas within 5 miles of the proposed site, ammunition storage areas within 3 miles; petroleum, oil and lubricants (POL) storage areas within 1 mile; routes of existing communication lines; routes of existing power lines; military installations in the vicinity and all likely sources of RFI.

3.2.2 Environmental Requirements

The natural drainage features and soil characteristics of proposed sites and expected extremes of climate must be considered since these factors affect the work that will be required to prepare a selected site for an earth terminal installation.

a. Natural Drainage Features and Soil Characteristics. A proposed site must not be susceptible to flooding and must be protected against heavy and sustained precipitation by adequate natural drainage.

The soil characteristics will determine how much preparation will be required for any proposed site. The extremely narrow beamwidth of the antenna requires that the antenna pedestal have a firm foundation. If the soil characteristics are not suitable for supporting a heavy antenna foundation, extensive concrete work may be required to support the antenna pedestal, the antenna and the radome. Moreover, the construction of the hardstands and the auxiliary buildings may be more complicated.

b. Climate. Extremes of the local climate should be considered in selecting a site. Although the design characteristics of the Phase I earth terminals permit operation under a wide range of environmental conditions, care must be exercised in the selection of sites to ensure that the expected extreme conditions will not exceed the design specifications. For example, there are significant variations in rainfall patterns within short distances in such places as Hawaii and the Philippines.

Design characteristics for the Phase I IDSCS earth terminals are listed in table 3-2. Note that these characteristics are for limited operational periods in some instances and do not apply to continuous operation.

3.2.3 Power Requirements

Although the Phase I IDSCS earth terminal equipments include transportable or mobile motor generator sets with sufficient capacity to operate the terminals, these generators will be used in Navy terminals for emergency backup only. Base primary and secondary power should be available to each proposed site. The ease of providing such base power is an important factor in site selection.

3.2.4 Physical Survivability

Although the Phase I IDSCS earth terminals have negligible inherent survivability, the choice of proposed sites should consider the survivability requirements of the users of the terminals. If the terminal is supporting only a single user it may be collocated with and require no greater survivability than that of the user. On the other hand, circumstances may dictate that a terminal serving several users be located at least 50 miles from a prime target area. To improve survivability, two or more terminals comprising an earth station should be separated as widely as local conditions will permit. If possible, a natural protection of high terrain between terminals should be sought so as to minimize concurrent damage from a single blast. Survivability requirements may dictate use of redundant interconnect links from a remote terminal location to provide a greater degree of survivability.

Table 3-2. Design Characteristics of AN/MSC-46 and AN/TSC-54 Earth Terminals

Ambient Air Temperature (design characteristics):		
	Maximum	Minimum
AN/MSC-46	+125° F	-25° F
AN/TSC-54	+120° F*	-25° F*
Relative Humidity (design characteristics): (operating)		
	Maximum	Minimum
AN/MSC-46	97% at 80-85° F	5% at 125° F
AN/TSC-54	100% up to 85° F	5% at 120° F
Maximum Wind Velocity (miles/hour) (design characteristics):		
(Without radome:)	AN/MSC-46 Antenna	AN/TSC-54 Antenna
Operational	30 (gust factor of 2)	30 (gust factor of 1.5)
Nonoperational	60 (gust factor of 1.33)	60
Survival (stow position)	120	125 (1/2 hour warning to place in stow position)
(With rigid radome:)	AN/MSC-46	AN/TSC-54
Operational	170 (gust factor of 1.33)	150

*Maximum design operating time for these conditions has been based on 4 hours performance capability.

3.2.5 Electromagnetic Interference

Communication satellite earth terminals should be sited in locations that minimize electromagnetic interference to the earth terminal from other radiation sources and also minimize electromagnetic interference to other electronic devices in the general area. The extremely low levels of the RF signals received by the Phase I earth terminals from IDCSP satellites require that extraneous electromagnetic interference be considered carefully in site selection. Similarly, the relatively high power of the earth terminal transmitted signals requires careful consideration of possible electromagnetic interference to nearby electronic equipments.

In the selection of sites both of the above kinds of electromagnetic interference should be considered, particularly in the azimuth sector involved in the expected sky coverage area.

3.2.6 Radiation Hazard Safeguards

Radiation hazards to personnel, fuels and ammunition may exist due to the radiated power from the earth terminals.

a. Personnel Hazard. A potential hazard to personnel exists in proximity to the antenna assembly of an earth terminal employing large aperture antennas and high powered transmitters. The acceptable maximum value of RF power density for continuous personnel exposure is 10 mW/cm^2 (average). The vertical cross section of the radiation hazard volume, based on the above maximum RMS RF power density, for the AN/MSC-46 earth terminal is shown in figure 3-5; that of the AN/TSC-54 is shown in figure 3-6. The radiation hazard volume at any proposed site relative to the required sky area coverage is a factor to be considered in site selection.

b. Fuel and Ammunition Hazards. Radiation hazards to fuel and ammunition vary depending on the types of fuel and ammunition concerned and the degree of exposure (in or out of shipping container, etc.). Allowable power density levels for fuel and ammunition are prescribed in the effective edition of NAVORD OP 3565/NAVAIR 16-1-529 — "Technical Manual Radio Frequency Hazards to Ordnance, Personnel, and Fuel." Although some items of ordnance are hazardous with power densities as low as 0.5 mW/cm^2 at the Phase I IDSCS frequencies, allowable power densities for fuel and ammunition generally are higher than those prescribed for personnel.

c. Transmitter Power Cutout Cam. To reduce the likelihood of inadvertent radiation hazards, a transmitter power cutout cam is provided. These cams should never be set for an elevation angle of less than 7.5°.

3.2.7 Collimation Facility

For Navy earth terminals in the Phase I IDSCS collimation facilities are not required.

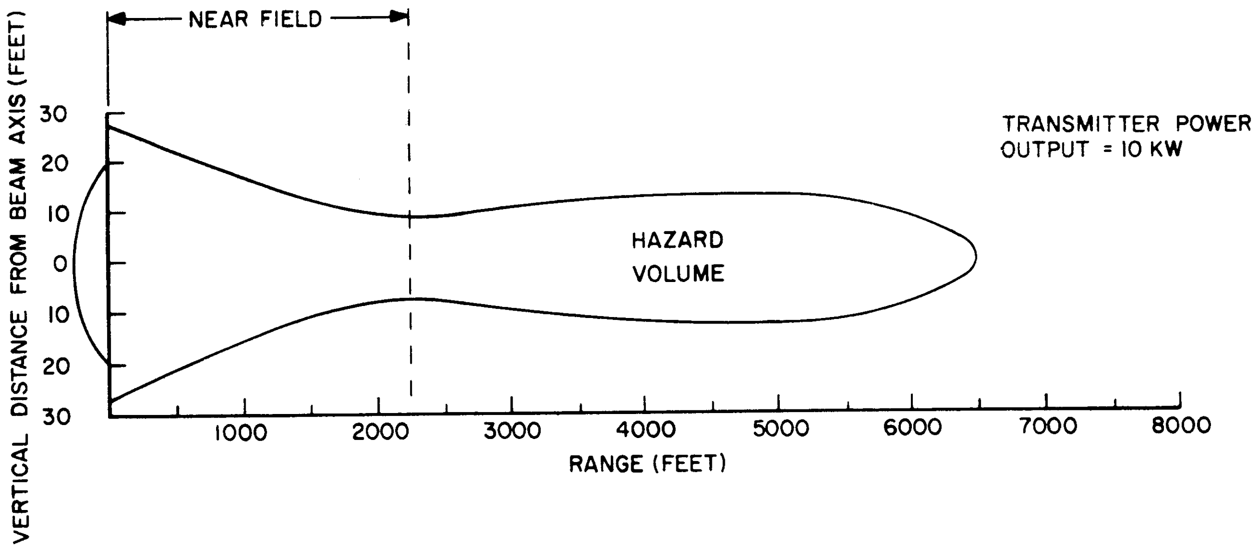


Figure 3-5. Vertical Cross Section of Radiation Hazard Volume for Power Density Level Contour (10 mW/cm^2) for Satellite Earth Terminal AN/MSC-46

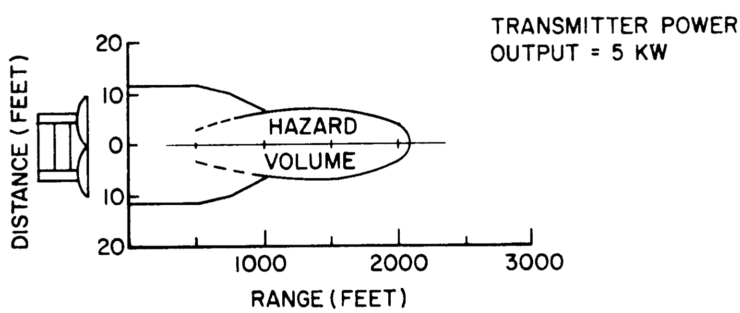


Figure 3-6. Vertical Cross Section of Radiation Hazard Volume for Power Density Level Contour (10mW/cm^2) for Mobile Satellite Earth Terminal AN/TSC-54

3.2.8 Access to Naval Communications Station

Navy satellite earth terminals will be connected either directly to a naval communications center or via a naval receiver station to its communications center. The type of interconnect link between an earth terminal and a naval communications station will depend upon the distance between the two locations and the conditions of the intervening terrain. Depending on local conditions, telephone system, hardwire, microwave, or troposcatter radio may be used. The maximum distance allowable for DC signaling via hardwire is two miles.

3.2.9 Site Survey Data

Much of the criteria to be considered in the evaluation of proposed sites can be determined from large scale topographic maps and other types of information about the local area. Preliminary evaluation of possible sites, based on available documentation, will eliminate some sites as obviously unsuitable and will direct attention to promising sites to be investigated further by an on-site survey team. Documentation of presurvey information concerning promising sites will facilitate the tasks of on-site survey teams and will expedite their survey. Forms for recording presurvey and on-site survey data are included in appendixes A and B respectively.

3.3 SITE PREPARATION AND INSTALLATION

After a particular site has been chosen, the installation of the earth terminal must be planned, designed and engineered to enable the operation of the terminal under the environmental conditions to be expected at the site. Although general design criteria apply to each site, reference to the technical manuals for each equipment to be installed is essential. Semipermanent installation of an earth terminal involves:

a. Preparation of the site.

b. Construction of foundations for the antenna pedestal and radome.

c. Connection of base and/or commercial power.

d. Construction of permanent buildings for the emergency generators, power switches, dummy load and LTTE.

e. Construction of hardstand area for trailer parking.

f. Preparation of semipermanent arrangements for interconnecting the various units of the earth terminals grounding the equipments and providing the necessary logistic and personnel facilities.

3.3.1 Foundations for Antenna Mount and Radome

Since the antennas for Phase I IDSCS earth terminals have very narrow beamwidths, they are very susceptible to any unintentional motion. Consequently, the antenna pedestal must have a very stable base. Because of the heavy weights of the antennas and their pedestals and the requirement for accurate antenna pointing, solid reinforced concrete foundations are required. The extent of these foundations will vary from location to location depending on the soil characteristics and extremes of climate expected. Foldout 3-1 shows a typical foundation for an AN/MSC-46 antenna pedestal and Figure 3-7 shows a typical foundation for an AN/TSC-54 antenna pedestal. All semipermanent earth terminal installations will include radomes to protect the antenna, antenna pedestal and associated equipment. These radomes, being relatively heavy, require reinforced concrete foundations. A radome foundation should be centered on the vertical center of movement of the antenna pedestal. Foldout 3-2 shows a typical radome foundation for an AN/MSC-46; and figure 3-8 shows a typical radome foundation for an AN/TSC-54. Again, reference to technical manuals for the specific equipments to be installed, giving due consideration to the environmental characteristics of the selected site, is essential to development of installation plans.

The area between the antenna foundation and the radome foundation should be paved and sloped (1/4 inch per foot) outward to the radome foundation. Means for draining tie-down hollows and the overall enclosed area should be provided, if warranted by expected climate conditions.

3.3.2 Other Site Construction

In addition to the antenna pedestal foundation and radome foundation, construction of permanent buildings for housing peripheral equipments will be required. These peripheral equipment buildings should be constructed in accordance with the normal procedures for the local area.

A hardstand for parking the vans should be constructed in the close vicinity and north (south in southern hemisphere) of the antenna and radome foundations. The AN/MSC-46 vans are 7 feet 10 inches wide, 29 feet long, and 11 feet high. The AN/TSC-46 operations shelter is 7 feet wide, 10 feet long, and 7 feet high.

If link terminal terminating equipment is required for the earth terminal, a building should be constructed specifically to house this equipment. In addition to space for the link equipment, space should be included for patchboards and test equipment, orderwire equipment, spare parts storage, coffee mess, head facilities and an administrative office. A microwave tower should be included if microwave is to be used.

A separate building should be constructed to house the generators furnished with the earth terminal equipments and any auxiliary converters or motor generators required to utilize base or commercial primary power. Switches to permit shifting to the various power sources should be provided.

3.3.3 Power and Emergency Power

A primary and a secondary source of electrical power should be provided for the earth terminal. These power sources can be either base-generated or commercial but they should be separate reliable sources. The generators furnished with the earth terminal equipment should be installed and wired to the equipments for use as emergency backup power. Fuel tanks for these emergency backup equipments should be installed and should be of sufficient capacity to operate the terminal equipment for one week. A dummy load should be provided for test purposes.

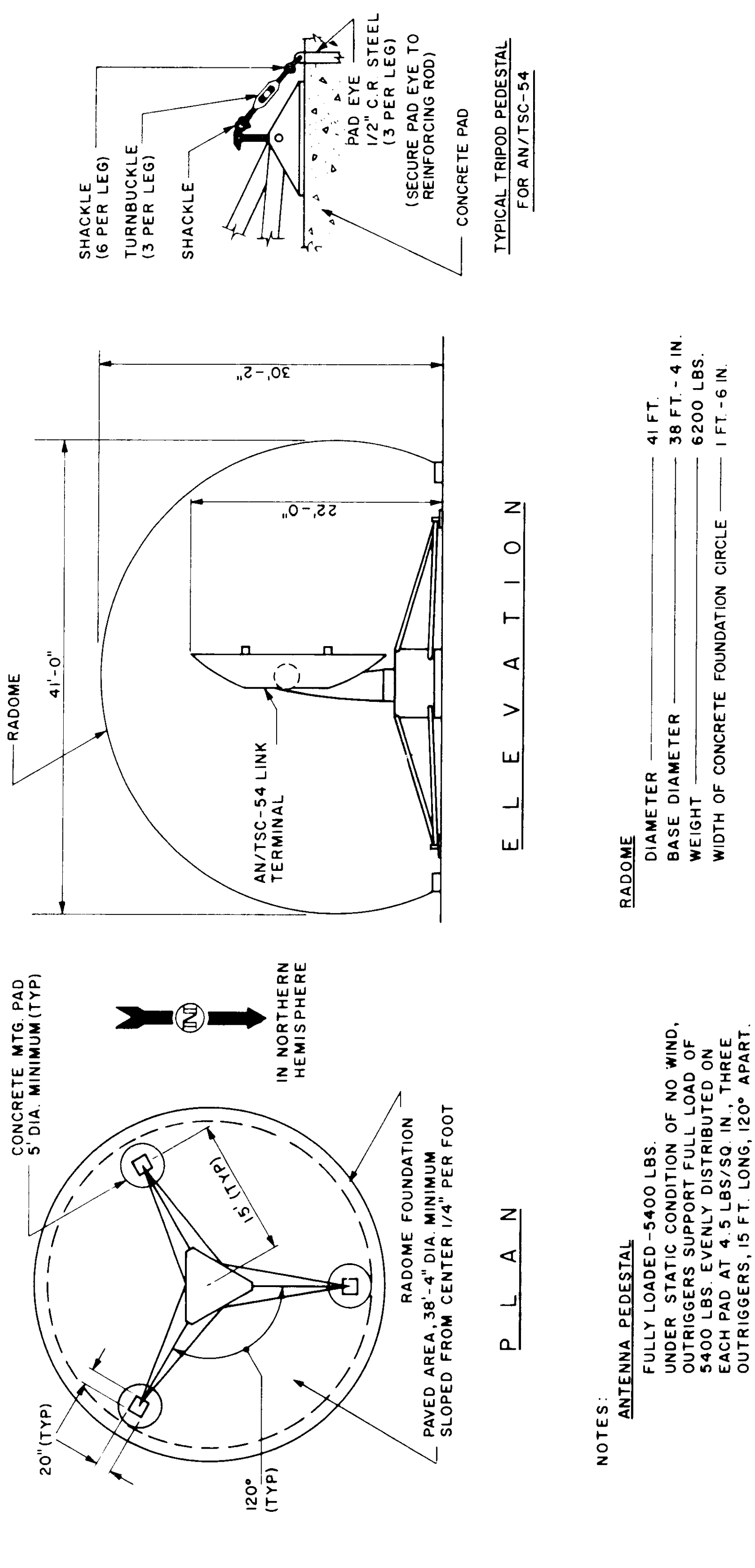
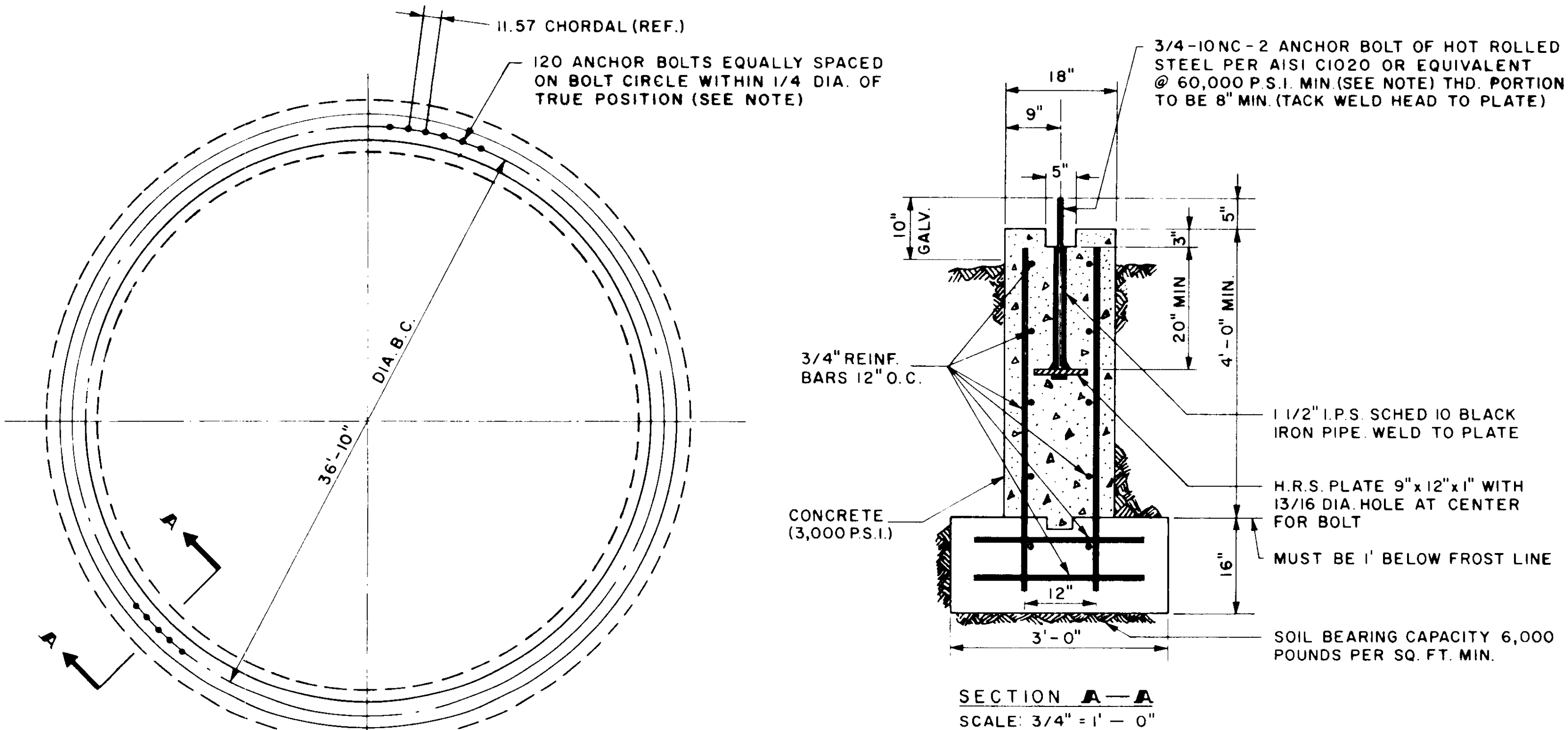


Figure 3-7. Typical Foundation for an AN/TSC-54 Antenna Pedestal



NOTE:

SUPPLY 3/4-10NC-2 HEX NUTS (240),
3/4 FLAT WASHERS(240), 3/4 LOCKWASHERS(240)
& 3/4 FLAT WASHERS LARGE PATTERN(120), ALL
OF WHICH TO BE OF GALVANIZED OR ZINC PLATED STEEL.

RADOME				
DRAG LBS.	LIFT LBS.	O.T.M. FT. LBS.	WEIGHT LBS.	WIND VELOCITY
36,000	81,000	410,000	6,200	150 M.P.H.

Figure 3-8. Typical Foundation for Radome for an AN/TSC-54 Antenna

a. Detailed Requirements for AN/MSC-46. Power required for the AN/MSC-46 terminal is 120/208 volts ±5%, 3 phase, 4-wire, 60 Hz. Average power consumed is 140 kW. The three diesel engine generators of 100 kW each, which are supplied with the equipments, should be installed as emergency power backup.

b. Detailed Requirements for AN/TSC-54. Power required for the AN/TSC-54 terminal is 120/208 volts, ±10%, 3 phase, 4-wire, 400 Hz. Peak power requirement is 45 kW. For present installations, two 45 kW diesel engine generators, type PU-608 A/G, are provided. In order to utilize station power, a rotary converter JHMX60H, type MG-1, is supplied to convert the 60-Hz station power to the 400-Hz power required by the terminal. This rotary converter takes 440-volt, 3 phase, 60-Hz power and delivers 120/208 volts, 3 phase, 400-Hz power, 45 kVA. Its weight is 4380 pounds.

c. Additional Radome Power Requirements. Although self-supporting radomes are not furnished as part of the AN/MSC-46 and AN/TSC-54 equipments, such radomes are available and usually are provided for semipermanent installations. If local site temperature and/or humidity conditions are such that special ventilating or air conditioning of the radome is required, additional 60-Hz power will be required.

d. Switching Arrangements. For semipermanent installations, adequate switching arrangements should be provided so that each source of power can be connected to the earth terminal and so that the emergency generators can be connected to a dummy load for testing. These switches are not supplied with the earth terminal equipments.

3.3.4 Earth Station Circuit Flow and Interconnect Criteria

Basically, satellite earth terminals are links used to connect the technical control facility (TCF) of one communications center to the TCF of another communications center, or to a DCS TCF. Figure 3-9 shows this relationship. The TCF of the communications center is the circuit control point. All circuit control personnel stationed at the earth terminal and the LTTE building are coordinated by and under the direct control of the TCF of the communications center. Routing of individual channels within the overall baseband signal received via the satellite earth terminal for distribution to users or for relay (including the use of regenerative equipment) is a function of the TCF and not that of the satellite earth terminal or the LTTE station.

A typical circuit distribution plan showing the interconnections between a communications center and a satellite earth terminal is shown in foldout 3-3. This plan provides for analog and digital, send and receive channels to the operating van for both reception and transmission of traffic. The number of these circuits is dependent upon the type of earth terminal being used. (The AN/MSC-46 can handle up to eleven nominal 4-kHz voice channels plus two orderwire teletype circuits. The AN/TSC-54 can handle one voice channel and two teletype circuits.) Sufficient peripheral equipment (patchboard, line conditioning, voice frequency carrier telegraph (VFCT), etc.) must be provided in the LTTE building to process and distribute the circuits in accordance with foldout 3-3. This equipment must be of such quality that at least one circuit can be conditioned to the S3 circuit parameter code for AUTOVON service. NAVELEX 0101, 102 — "Naval Shore Electronics Criteria Naval Communication Station Design" contains a description of the circuit parameter codes. Foldout 3-3 shows teletype equipment for orderwire use in both the LTTE building and the operating van. The orderwire circuit extends from the operating van and the LTTE building to the TCF in the communications center. Hubber units are used at the TCF to allow operators at the TCF, LTTE, and operating van to communicate with one another and to communicate

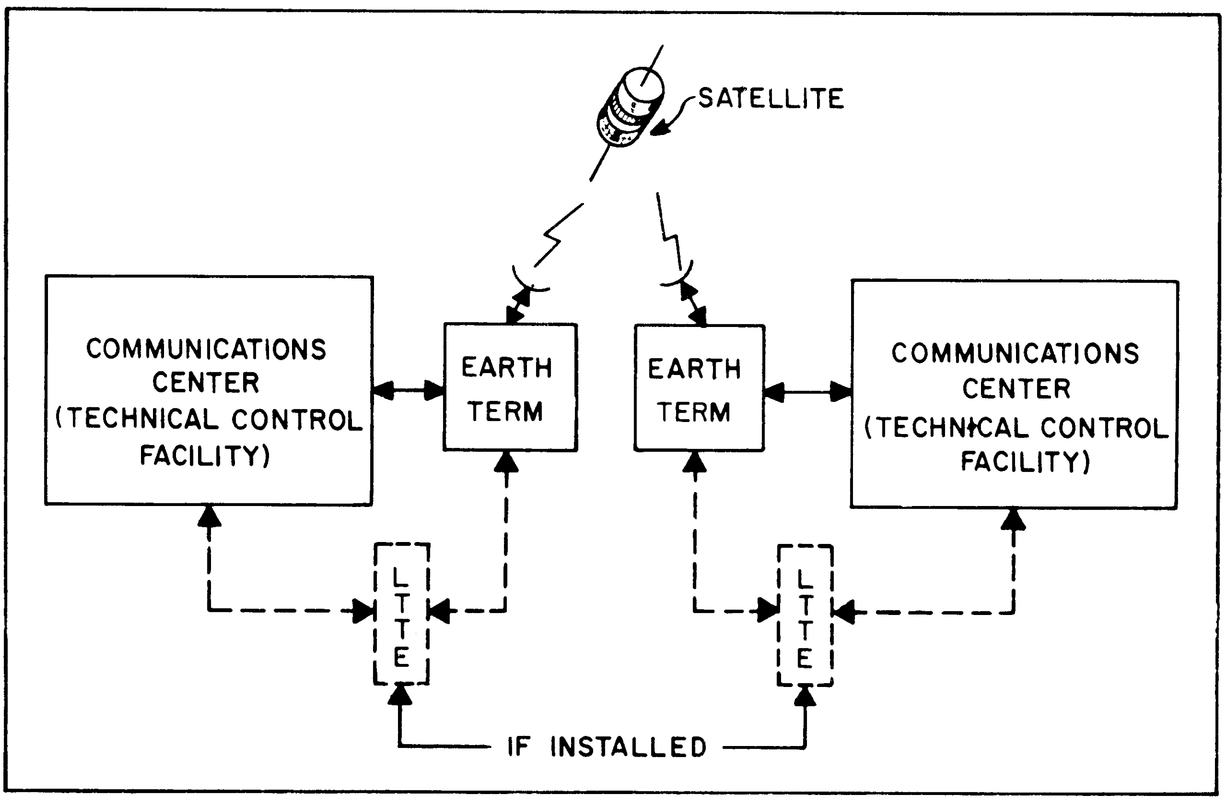


Figure 3-9. Satellite Communications Circuit

over the satellite link to the next communications center. When the LTTE and the operating van are combined into a single complex, the orderwire teletype equipment shown for the operating van would be eliminated.

The general criteria applicable to the equipment installation and wiring are identical to that given in NAVELEX 0101, 102. The cabling between the buildings and the van is standardized to the 26- and 52-twisted pair cables indicated in foldout 3-3. All DC signals are transmitted over a 26-twisted pair individually shielded cable, pressurized with nitrogen, while all audio or analog signals are transmitted over the 52-twisted pair overall shielded cable. Individual wires are solid copper, either 19- or 22-gauge; the 22-gauge being used for runs up to one mile and the 19-gauge for runs up to two miles. A minimum separation of 8 inches is to be maintained between these two cables throughout their entire run. These two cables provide approximately 100 percent spare pairs to allow for possible facility expansion. The quantity and arrangement of equipment must also be planned with provision for maintenance and for system expansion. The VFCT equipment must have one additional channel as a spare for each group of five channels or portion thereof in use.

3.3.5 Grounding Criteria

a. Equipment Grounds. No RF counterpoise ground is required. Provisions should be made for grounding the various component parts of the earth terminal for personnel safety. The equipment ground should be used as the signal ground. The combination power and signal ground should have not more than 25 ohms resistance to earth. (NAVELEX 0101, 102 contains a description of two methods of measuring the effectiveness of an installed ground.) When the LTTE building is not collocated with the earth terminal trailers, both the LTTE building and earth terminal trailers should have their own ground rods.

b. Lightning Rods. A lightning rod with proper grounding should be installed at the top of the radome (if it is not already provided).

c. Red-black Conditions. If red-black security conditions exist in an operations van or shelter, grounding shall comply with the criteria set forth in DCA 300-175-1 and NAVELEX 011120.1.

3.3.6 Other General Site Preparation Considerations

Provisions should be made to protect the various interconnect cables and the equipment coolant piping. Environmental conditions at the earth terminal site govern whether cables and piping should be installed in shallow protected trenches or on elevated protected hangers as shown in figure 3-10. Drainage features should be included for both types of cable runs.

Special precautions should be taken to assure continuous operation of the earth terminal under expected environmental conditions. In hurricane or typhoon areas, special provisions for tie-down anchors and other precautions against high velocity winds should be taken. Air conditioning and fungus preventative actions may be required in hot and humid locations. Similarly, special heating and ventilation measures should be taken in cold areas. Normal construction procedures in use for any particular area should be followed with due consideration given to the sizes and weights of the major units of the earth terminal.

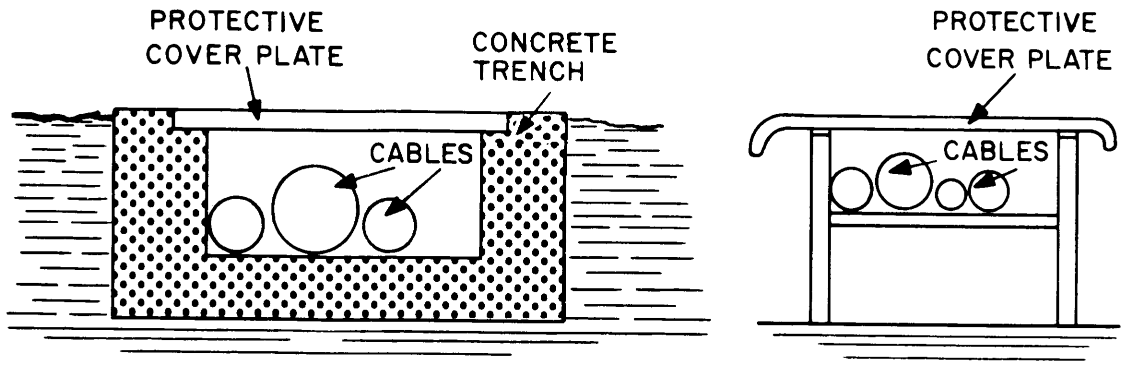


Figure 3-10. Types of Cable Runs

3.3.7 Personnel and Logistic Support

Normal shore station installations for berthing, messing and recreational facilities for operating and maintenance personnel should be available. Similarly, complete logistic support must be furnished.