MIL-HDBK-420
20 March 1987

MILITARY HANDBOOK

SITE SURVEY HANDBOOK
FOR
COMMUNICATIONS FACILITIES

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DEPARTMENT OF DEFENSE
Washington, DC 20301

SITE SURVEY HANDBOOK FOR COMMUNICATIONS FACILITIES

1. This Military Handbook is approved for use by all departments and agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data that may be of use in improving this document should be addressed to: Director, U.S. Army Information Systems Engineering and Integration Center, ATTN: ASBI-SST, Fort Huachuca, Arizona 85613-7300, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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1. SCOPE

1.1 **Purpose.** This handbook describes responsibilities and suggests procedures for conducting site surveys. It is not intended to serve as a stand-alone comprehensive reference for generating reports. Rather, it is to be used in conjunction with existing site-specific handbooks and other applicable documents to identify requirements needed to support the acquisition, establishment, or upgrading of telecommunications sites.

1.2 **Content.** This handbook contains sections that give the responsibilities, operational duties, and data collection requirements for both the presurvey and the on-site survey teams. Section 4 (General Requirements) contains site installation categories, survey team composition, responsibilities, team operation, and report generation guidelines. Section 5 (Detailed Requirements) identifies data requirements that are: (1) common to all telecommunications facilities and (2) related to specific types of telecommunications sites. Appendixes contain detailed information, sample calculations, and data collection worksheets. The data collection worksheets, as modified by the survey team, form the nucleus of the data collection workbook used by both the presurvey and the on-site survey teams. Since information requirements and report formats used by military departments can differ significantly, this handbook contains no recommended format. The site survey team should contact the department with approval authority for guidance on report format and content.

1.3 **Application.** This handbook is intended as an aid in the performance of telecommunications site surveys. It is applicable to the establishment or expansion of line-of-site stations, tropospheric scatter stations, satellite communications earth terminals, high frequency transmitter and receiver stations, interconnect communications facilities, submarine cable terminals, fiber optic communications, switching centers, and local area networks.

1.4 **Safety.** Telecommunications equipment normally involves high voltages and, in some installations, high-energy radiation fields. Systems and subsystems discussed in this handbook shall comply with the safety requirements established in MIL-STD-882, the safety portion of MIL-STD-1472, and OSHA 1910.

2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 **Specifications, standards, and handbooks.** Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this handbook to the extent specified herein.

STANDARDS

FEDERAL

FED-STD-1037	Glossary of Telecommunication Terms

MILITARY

MIL-STD-188-124	Grounding, Bonding, and Shielding for Common Long Haul/Tactical Communication Systems, Including Ground Based Communications-Electronics Facilities and Equipments
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of
MIL-STD-633	Mobile Electric Power Engine Generator Standard Family Characteristics Data Sheets
MIL-STD-882	System Safety Program Requirements

HANDBOOKS

MIL-HDBK-232	(C) RED/BLACK Engineering-Installation Guidelines (U)
MIL-HDBK-412	Site Survey and Facility Design Handbook for Satellite Earth Stations
MIL-HDBK-413	Design Handbook for High Frequency Radio Communications Systems
MIL-HDBK-415	Design Handbook for Fiber Optic Communications Systems
MIL-HDBK-416	Design Handbook for Line of Sight Microwave Communication Systems
MIL-HDBK-417	Facility Design for Tropospheric Scatter (Transhorizon Microwave Systems Design)
MIL-HDBK-419	Grounding, Bonding, and Shielding for Electronic Equipments and Facilities

2.1.2 **Other Government documents.** The following other Government documents form a part of this handbook to the extent specified herein.

DEPARTMENT OF DEFENSE (DoD) MANUAL

DoD 4270.1-M	DoD Construction Criteria Manual

DEFENSE COMMUNICATIONS AGENCY HANDBOOK

Command Center Design Handbook, Volume 2

NATIONAL SECURITY AGENCY MEMORANDA

NACSIM 5203	(C) Guidelines for Facility Design and RED/BLACK Installation (U)

MILITARY MANUALS

(Army) FM 11-65	High Frequency Radio Communications
(Army) FM 11-372-2/ (Air Force) TO 31W3-10-12	Outside Plant Cable, Placement
(Army) FM 11-486-5/ (Air Force) TO 31W3-10-22	Telecommunications Engineering, Outside Plant, Telephone
(Army) FM 11-486-7/ (Air Force) TO 31Z-10-22	Telecommunications Engineering, Electrical Power Systems for Telecommunications Facilities
(Air Force) TO 31-10-3	Standard Installation Practices, Outside Plant Installation
(Air Force) AFM 88-15	Air Force Design Manual Criteria and Standards for Air Force Construction
(Air Force) AFM 127-100	Explosive Safety Standards

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION REGULATIONS

29 CFR 1910	OSHA Safety and Health Standards, General Industry

2.2 **Other publications.** The following documents form a part of this handbook to the extent specified herein. The issues of documents that are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. The issues of the documents that have not been adopted shall be the ones in effect on the date of the cited DoDISS.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

ANSI/IEEE Std 446, IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Application.

AMERICAN SOCIETY OF HEATING, REFRIGERATION, AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE GRP 158, Cooling and Heating Load Calculation Manual.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70, National Electrical Code (NEC).

2.3 **Order of precedence.** In the event of a conflict between the text of this handbook and Federal or Military Standards, the text of the standard shall take precedence. In the event of a conflict between this handbook and another Military Handbook, the more specific handbook shall normally take precedence. For example, at a satellite earth station, the Military Handbook on that subject (MIL-HDBK-412) would take precedence. Similarly, a conflict concerning grounding, bonding, and shielding procedures would be resolved in favor of the handbook that deals specifically with that subject, in this case, MIL-HDBK-419. Where conflict exists, the survey report shall note the conflict, state which guidance was followed, and give the rationale for selecting that guidance.

2.4 **Sources of documents.**

2.4.1 **Government specifications, standards, and handbooks.** Copies of the referenced federal and military specifications, standards, and handbooks are available from the Department of Defense Single Stock Point: Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120-5099. For specific acquisition functions, these documents should be obtained from the contracting activity or as directed by the contracting activity.

2.4.2 **Other Government documents.** Copies of other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.

2.4.3 **Non-Government publications.** Non-Government documents are generally available for reference from libraries and technical groups. The documents listed in 2.2 may be obtained as follows:

a. ANSI: Applications for copies should be addressed to the American National Standards Institute Inc., 1430 Broadway, New York, NY 10018.

b. ASHRAE: Applications for copies should be addressed to the American Society of Heating, Refrigeration, and Air-Conditioning Engineers, 1791 Tullie Circle NE, Atlanta, GA 30329.

c. IEEE: Applications for copies should be addressed to the Institute of Electrical and Electronics Engineers Service Center, 445 Hoes Lane, Piscataway, NJ 08854.

d. NFPA: Applications for copies should be addressed to the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

3. DEFINITIONS

Definitions. For definitions of the terms used in this handbook, refer to Federal Standard 1037 (Glossary of Telecommunication Terms).

4. GENERAL REQUIREMENTS

4.1 **General.** The success of the on-site (field) part of a survey is closely related to the completeness and accuracy of data compiled by the presurvey effort. This information, developed from the preliminary system design phase, should be completed prior to departure of the survey team to the field. For purposes of this handbook, survey information has been categorized as either site-common (applicable to all types of sites) or site-specific (applicable only to a specific type of site, such as a tropospheric scatter station). Site-common data elements, such as real estate, power, and grounding requirements, are recorded on worksheets separate from those that are site-specific. This separation may be helpful in on-site task assignments by the survey team chief.

4.2 **Site installation categories.** There are three installation categories for which surveys are conducted: (1) new facility in new territory, (2) new facility at an established communications site, and (3) upgrade of an existing facility. Much of the information to be collected is common to all three categories (such as directions for reaching the site). Other data might be common, but require different degrees of detail. For example, at a new site, the availability of electric power, water, and sanitary disposal means must be determined, whereas at an existing facility, only an investigation into the adequacy or possible modification of utilities is needed. In general, new facilities in new territories require the greatest amount and detail of data collection, and the upgrade of existing facilities the least.

4.3 **Composition of the survey team.** The survey team will vary in size and expertise depending on the mission and the point-in-time of the survey process. For example, on a major survey project, one would expect to find significant differences in the team composition during the presurvey effort and during the on-site visits. Paragraphs 4.3.1 and 4.3.2 contain a list of agencies and individuals that could be expected to participate in a typical site survey.

4.3.1 **Military department representatives.**

a. Communications engineering agency.

b. Operating command.

c. Major area command.

d. Operating unit.

e. Logistics support base.

f. Facilities engineer/construction agencies.

g. Local (e.g., base-level) frequency management personnel.

4.3.2 **Other representatives.**

a. Military assistance advisory groups, military attaches, State Department representatives.

b. Contractor representatives.

c. Host-country representatives.

4.4 Survey responsibilities.

4.4.1 **Military department communications engineering agency.** When tasked to establish, expand, or upgrade a communications site, an engineering agency will:

a. Coordinate the establishment of the site survey team to include instructions as to team composition, time, or place of meetings or assembly areas.

b. When required, obtain host-country approval for conducting the survey, inform area officials of the survey, and obtain an area clearance prior to the arrival of the survey team.

c. Provide the survey team with specific technical guidance (survey directive).

d. Obtain data that is beyond the collection capabilities of the survey team.

e. Provide administrative assistance to the survey team in support of activities not conducted at the site or in the general area of the site. During its presence on site, the team will receive administrative support from the local operating command.

f. Request outside engineering assistance when specialized knowledge or equipment is needed to support the site survey.

4.4.2 **Project engineer.** The agency communications engineer with overall responsibility for the project should provide specific guidance to the survey team in the form of a 'survey directive.' This directive will act as the team's charter in developing a plan for performing the site survey. As a minimum, the directive should prioritize data collection needs with special instructions for critical or nonstandard requirements. It also should give the format and final date on which the completed survey report must be submitted. Specific guidance as to required content or level of detail will aid the survey team chief in allocation of resources.

4.4.3 **Survey team.** The team's responsibilities include the following:

a. Perform preliminary feasibility engineering and resource requirement studies (presurvey) to determine whether a particular site can support the telecommunications facilities identified in the survey directive.

b. Perform on-site reconnaissance (site survey) to collect or verify topographical, geological, climatological, electromagnetic, and other pertinent data needed for the site selection process.

c. Prepare and staff the completed site survey report.

4.4.4 **Operating command.** The operating command will provide qualified individuals (preferably from the subordinate unit that will be responsible for the site) to serve as members of the survey team. These personnel will:

a. Participate in all aspects of the survey and provide specific telecommunications requirements, recommendations, and other input from an operational viewpoint.

b. Provide input concerning support capabilities of the operating command.

c. Indicate conflict, if any, with other pending projects (e.g., an approved program scheduled to use the same space, power, and cooling).

d. Act as the primary point-of-contact between the operating command and the survey team for on-site visits.

e. Provide administrative support for the site survey team during the team's presence at the site.

4.4.5 **Major area command.** The major area command will designate a representative to:

a. Participate in survey activities by providing input from the area command viewpoint.

b. Obtain special information needed by the area command staff to plan and budget effectively for future support of new sites and facilities.

c. Indicate command concurrence or nonconcurrence (with appropriate narrative) to authenticate completed survey documents.

4.4.6 **Local logistics support command.** The local logistics support command, in coordination with the operating command, will provide:

a. Representation at the site survey in-briefing.

b. Logistic support for the site survey team (e.g., housing, subsistence, transportation, conference room, and clerical assistance).

c. Local area information as required during site survey coordination meetings.

d. Aid in obtaining specific logistics data as required.

e. Information regarding anticipated logistic support difficulties either with facility implementation, delivery, or storage of Government-furnished and contractor equipment.

f. Information regarding construction constraints or other unusual requirements dictated by local ordinances or customs.

g. Sign the completed survey documents indicating concurrence or nonconcurrence.

4.5 **Survey team procedures.** Paragraphs 4.5.1 and 4.5.2 provide a list of generalized procedures that a survey team can adapt to its particular needs.

4.5.1 **Preliminary activities.** The survey team chief shall ensure that the following actions are accomplished before on-site survey activity begins.

a. If not already provided by the survey directive, determine what information, level of content, and reporting format is required.

b. Select team members and establish a work schedule for the presurvey effort.

c. Identify the locations of other sites with which communications must be established.

d. If the survey involves an existing site, research available 'plant-in-place drawings' to obtain the latest site status. Since sites seldom have extra copies of the latest drawings, updating older or obsolete drawings may be more expedient than preparing new ones. If none are found, contact the civil or facility engineer concerned.

e. Generate site data workbooks.

(1) Determine what information is needed to make site selection decisions.

(2) Compile the workbook from: (a) applicable worksheets from the appendixes of this handbook, (b) team-modified versions of the worksheets, and (c) team-developed worksheets.

f. Collect and review applicable documents or other compiled information.

g. Determine what data items must be completed by the on-site survey team.

h. Identify and obtain any instrumentation and equipment that will be required during the on-site survey.

i. In instances where a preliminary visit must be made before the actual survey, ensure proper coordination for transportation, logistical support, lodging, notification procedures, site access, and any required host-country escorts. Time constraints, economics, or other considerations might not allow waiting until the actual survey.

4.5.2 **On-site activities.** During the on-site portion of the survey, the team chief, or other designated team member(s), should:

a. Organize and define procedures to be used in collecting data. (See section 5 for detailed information collection instructions.)

b. Arrange for logistical support (housing and transportation) and clearances (security and site access) for team members.

c. Establish and coordinate the daily work schedule.

d. Coordinate with U.S. and host-government agencies, civilian activities, and military organizations having an interest in the site. As a minimum, conduct an in-briefing upon arrival in the survey area and an out-briefing before departure.

(1) The following topics should be discussed at the in-briefing:

(a) The purpose, scope, and authority for the project.

(b) The impact on the local area (e.g., increased requirements for billets, family housing, medical services, administrative support).

(c) Assistance required from local representatives.

(d) The criteria to be used in selecting the site.

(e) The availability and suitability of land, buildings, and utilities.

(f) Permission to take photographs or make video recordings .

(2) The following topics should be discussed at the out-briefing (authenticate any agreements on critical issues with a memorandum signed by the parties involved):

(a) The proposed site(s).

(b) The real estate that will be required.

(c) Site preparation and construction requirements.

(d) Implementation and construction schedules.

(3) Attendees at briefings should include, but not be limited to the following:

(a) The local area commander (U.S. and host country).

(b) Representatives of the local government.

(c) The local civilian engineer or public works officer and members of the local master planning board.

(d) The local military communications-electronics officer, local military frequency spectrum manager, and civilian equivalents.

e. Conduct the on-site survey in accordance with the procedures and guidance developed at the site survey planning meetings, as modified by the information derived from the in-briefing. Tentative layout drawings should be made at the field locations. Collected data should be organized into a form suitable for field or office evaluation. To facilitate this collection, the team chief should:

(1) Ensure that all required items in the data workbooks are completed.

(2) Monitor the field performance of any contractor personnel associated with the survey. In the event of technical controversies involving the contractor, make every effort to resolve the difference. Any unresolved differences should be referred to the agency responsible for accomplishing the survey.

(3) Provide consolidated survey information to the activity responsible for producing the formal survey report.

4.6 **Report preparation and processing.** Prepare and staff the site survey report in the required format. A checklist of information that should be included is contained in appendix A. The following organization is suggested:

a. A summary of the findings and recommendations.

b. Identification of critical information not obtainable during the survey, justification for not including this information, recommendations for designating agencies to provide the missing data, and, if appropriate, an estimate of when the information will be available.

c. Supporting data.

d. To the extent possible, estimates of construction and installation costs.

e. Completed site survey data workbooks.

f. Concurrences/nonconcurrences of reviewing commands/agencies.

g. Separate correspondence to forward classified material.

5. DETAILED REQUIREMENTS

5.1 **General.** The key to success in any site survey is to obtain all required data. The data worksheets in appendix F may be tailored by adding or deleting material as needed. The site survey team should continuously update the worksheets to ensure that all required data are entered. Information collected during the presurvey phase will be provided to the on-site survey team. This information should contain raw data for on-site verification and a narrative evaluation backed by the raw data. The presurvey team should also provide the on-site team with a number of alternative site locations. It is advisable for the on-site team to take pictures (still, motion, or video) of the surrounding terrain and of the interior of the equipment building (see 5.3.6). Photographs and video recordings of existing sites may require a security classification. This determination is made by the appropriate operating command. In any event, obtain permission before taking any pictures.

5.2 **Preliminary on-site survey.** A quick site evaluation can avoid wasted effort and should be performed before any detailed on-site data collection is begun. Any obvious unsuitability (such as a tropospheric microwave site with a horizon angle of +2 degrees or more), which would eliminate the site from consideration, should be examined. Time permitting, a preliminary site survey should be conducted to verify questionable disqualifying data at sites considered but deemed unsuitable in the presurvey evaluation.

5.3 **Site-common data.** Paragraphs 5.3.1 through 5.3.15 contain data common to all telecommunications facilities. Common data element worksheets are located in appendix F, annex A.

5.3.1 **Facility identification.**

5.3.1.1 **Site identification number or name.** For existing sites, record the site identification number or name.

5.3.1.2 **Type of facility.** Record the type of telecommunications facility (e.g., tropospheric scatter microwave, line-of-sight microwave, switching center) for which the survey is being conducted.

5.3.1.3 **Site location.** Prepare detailed instructions for reaching the site from an easily recognized point of origin (e.g., city or major landmark). The instructions should contain road names, directions, and mileage from the point of origin. If possible, mark the route on the best available road or topographic map.

5.3.1.4 **Geodetic position.** Provide the most accurate site location possible. This can be either military (UTMG) or latitude and longitude coordinates. For sites on an existing military installation, the facility engineer can provide this information. For other locations, a city or county civil engineer's office or similar host-country agency should be contacted. In the event that such sources are unavailable or not to the required accuracy, the site survey team must be prepared to determine site location through one or more of the common surveying techniques.

5.3.1.5 **Baseline azimuth.** The baseline azimuth is referenced from true north. Depending on the degree of accuracy specified in the survey directive, it may be determined on site by compass, triangulation, traverse, or solar/stellar observations. If either triangulation or traverse is employed, provide identification and location of the topographic bench marks used.

5.3.1.6 **Site elevation.** For smaller sites, less than 330 ft (100m) across, give the mean elevation. Depending on the required accuracy specified in the survey directive, altitude above sea level can be determined from map inspection, a calibrated barometer, or vertical angle observations between the site and local survey bench marks. Larger installations that might entail extensive on-site improvements or construction, such as an HF receiver site, require a small-scale contour map to show elevation detail within the site boundaries.

5.3.2 **Real estate.** The proposed purchase or lease of real property by the Federal Government is considered proprietary information.

5.3.2.1 **Availability.** Survey team members shall not inquire into the availability or cost of private property, nor shall they divulge the suitability of any prospective site to indigenous personnel. The area agency with land procurement authority should be tasked to obtain this data. Regardless of the qualifications of the site, it is valueless if it cannot be made available in time to meet the program schedule. The procedures for obtaining lands from governmental agencies or from private ownership may be lengthy and time consuming. An alternate site should be sought if it appears that there might be insufficient time to build on the site or to install a facility after the land becomes available.

5.3.2.2 **Ownership.** It is of prime importance to establish ownership of possible sites and rights-of-way or address through which the owner or governing agency may be contacted. The ownership and legal description of the land can usually be obtained locally from the city, township, or county clerk's office or an equivalent host-country governmental agency. The purchase of land for access roads can often be eliminated by obtaining an easement to the site. The use of existing roads might require that a lease or agreement be entered into with the governing agency or owner.

5.3.2.3 **Site access.** The survey team should report the condition of existing access roads and highways leading to the site. These conditions include slope, constrictions, curves, locations of bridges and culverts, drainage, surfacing, turnouts, weather effects, weight limits, and overhead clearance. For each bridge between the proposed site and its main supply location, weight and size limits (contact the local civil engineer) must be recorded. When access roads to the site do not exist, the survey team should prepare a map showing the location of the site in relation to existing roads, suggested routing, contours, vegetation, and, if possible, the surface and subsurface soil conditions. Information concerning ownership of proposed or existing access road property should be recorded.

5.3.3 **Soil and drainage.** Information on soil and drainage should include data from percolation tests, run-off data, flood history, soil load-bearing data, and the locations of buried obstructions (such as utilities) that might interfere with the routing of buried cable or the placement of antenna supports. Check first to see if this information is available from local civil engineers. If not, the survey team must gather its own data. At existing installations, subsurface soil data may be available from existing borings or foundation excavations in the area near the new location. When this information is available, copies should be obtained and included with the survey report. If required, subsurface information can be obtained by digging test pits for visual observation and taking penetrometer readings of the bearing capacity at each change of strata. Test pit locations are to be recorded on the site topographic drawing. Soil samples should be taken from the test pits and kept in jars. These samples must be properly identified, recorded, and submitted for laboratory analysis. The depth of the ground water table and seismic data shall be obtained when possible. The source of this information shall also be recorded. If site access cannot be obtained during the survey period, visual observation of the surface will suffice.

5.3.4 **Weather and seismic information.** Weather data should be obtained from the nearest U.S. Weather Bureau Station, military weather station, or indigenous weather bureau. If the station or bureau is a great distance from the site and there is a significant difference in weather conditions, this information should be noted on the data sheets. General information on lightning activity in the Continental United States (CONUS) is shown in figure 1. If more information is needed, contact the National Oceanographic and Atmospheric Administration, U.S. Department of Commerce Boulder Laboratories, 325 Broadway, Boulder, Colorado 80303. Information from nonlocal sources (such as the weather maps just described) should be compared with information from local sources; any significant differences should be noted in the survey report. Records of seismic activity are usually available from a nearby university geophysics department.

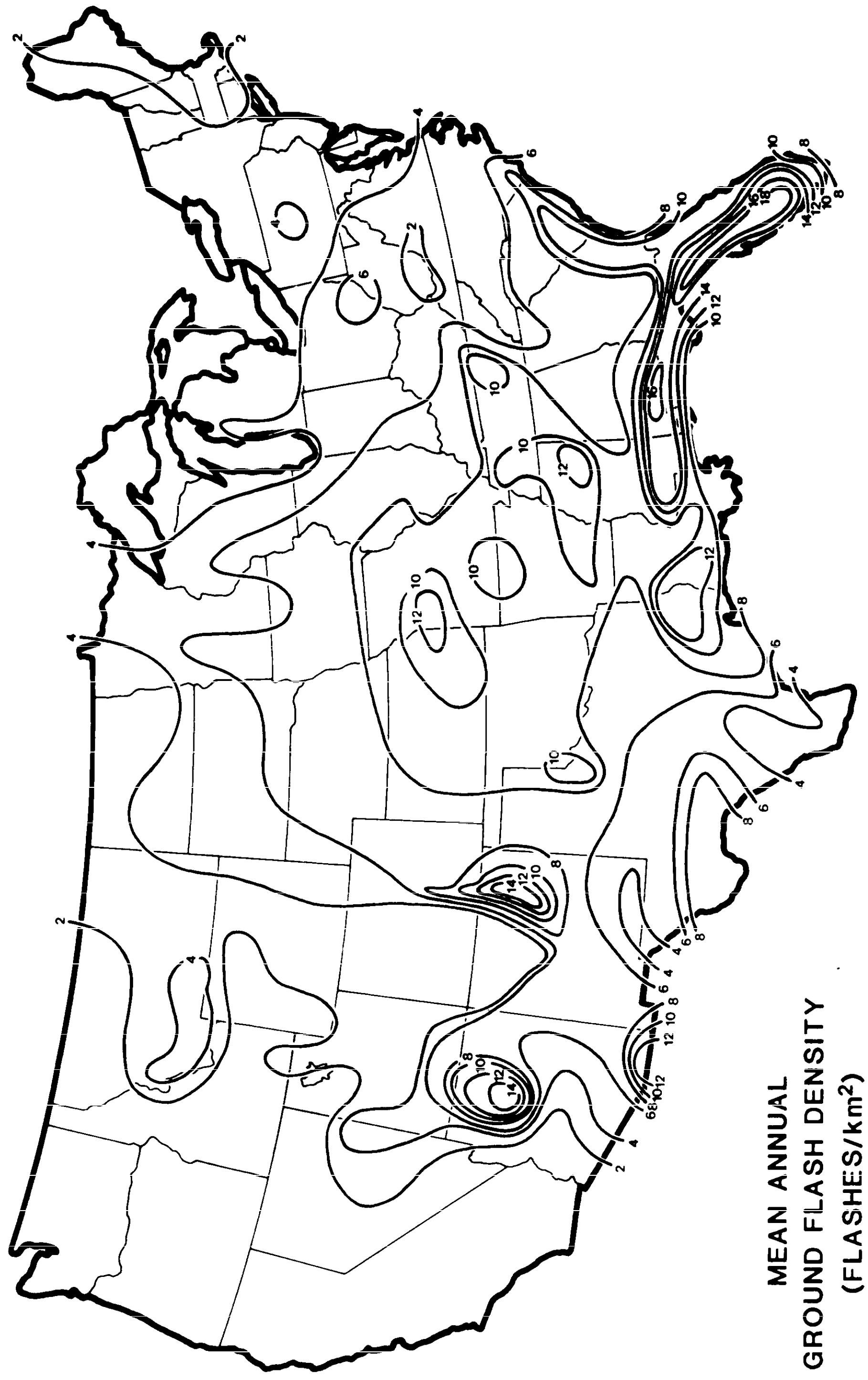


FIGURE 1. Lightning activity map for CONUS.

5.3.5 **Topography and terrain.** The amount of topographic information needed depends on the type of telecommunications site. In the case of a switching center in an existing structure, little or no topographic data are required. However, a new tropospheric scatter station would require extensive topographic data. The survey directive and specific site appendix of this handbook will determine the data required. When topographic maps are required, they should include all physical features within and beyond the site boundaries which could affect the electronic suitability of the site. All topographic and terrain data should be referenced to a base line connecting the site marker and a local survey reference. The base line should also be referenced to existing construction or other easily identified objects. The location of all structures, natural objects, heavily vegetated and wooded areas, and isolated trees on the site should be recorded on a map or a sketch.

5.3.6 **Photography and video recording.** A set of still or motion photographs or video tape recordings should be taken to display a 360-degree panoramic view. This photography provides a pictorial representation of the visible horizon and should show the near-field surface terrain for sites emitting electromagnetic radiation. The camera should be mounted on a tripod or affixed to a transit head such that each exposure will cover uniform azimuth increments. A stadia rod should be adjusted for camera height and appear in each photo. Identify each azimuth increment by including a chalk board identifier in the exposure foreground (motion pictures and video recordings should also employ a method of indicating azimuthal references). The use of infrared film with suitable filters will give good definition even through haze. With ordinary black and white film, an orange or red filter will give increased definition. Instant developing film cameras are useful for previewing exposure composition. However, the panoramic view should be taken with a conventional camera or other means that will provide negatives or high-resolution data base for future reproduction or enlargement.

5.3.7 **Electromagnetic environment.** The existing and planned electromagnetic environment at the site should be determined as accurately as possible before actual measurements are started. The local military spectrum manager will have detailed knowledge of existing and planned transmitters and receivers in the area. At some sites, anomalous propagation conditions can be a major factor in determining potential interference. The military spectrum manager will also know how to contact the spectrum managers from other Federal agencies that might have extensive telecommunications facilities in that area. The DoD Electromagnetic Compatibility Analysis Center (ECAC) maintains a large data base of military, Federal, and civilian telecommunications equipment locations and parameters. The local spectrum manager can assist the team in sending a written request to the DoD ECAC for a computer-generated list of all telecommunications equipment within a specified radius of the site and an estimate of the power density generated by local transmitters, or, if necessary, power received from satellites beamed at the site.

5.3.8 **Construction and facility-related information.**

5.3.8.1 **Construction.** New construction requires that research of regional and local construction codes or ordinances be conducted during the site survey. Although primary responsibility rests with the local area commander or governing agency, lack of attention to this critical issue can result in costly delays in site occupation. Plans for new construction or modification of existing structures are contained in the presurvey data package. (See appendix B for additional background information.)

5.3.8.2 **Construction period.** Due to climate and other factors, construction might not be feasible during portions of the year. This information should be obtainable from the local area civil engineer or a similar host-country official.

5.3.8.3 **Local laws and customs.** The local government should be contacted to identify any laws, customs, and ordinances concerning architecture or construction techniques.

5.3.8.4 **Personnel constraints.** Identify any limitations placed on the construction workforce by host countries.

5.3.8.5 **Local capabilities.** The on-site survey team should investigate the available labor pool, equipment, materials, and local contractor capabilities. The collected data should be in sufficient detail to allow: (1) accurate cost estimates and (2) proper evaluation of local materials and labor.

5.3.8.6 **Land requirements.** The proposed placement of access roads, buildings, and other site-support structures should be chosen to minimize real estate costs.

5.3.8.7 **Building and environmental control requirements.** Record architecture requirements, building interior space requirements or availability, and heating and cooling requirements. For expansion or upgrade of an existing facility, indicate whether the present building(s) will support raised floor construction.

5.3.9 **Grounding, bonding, and shielding of existing facilities.** Procedures for evaluating grounding, bonding, and shielding at existing sites are provided in Volume 2 of MIL-HDBK-419. (See also MIL-STD-188-124.) The site survey team should have ready access to both of these documents during site surveys.

5.3.10 **Soil resistance.** Telecommunications sites require a low-resistance connection to earth at power line and signal frequencies. To properly design a new site earth electrode subsystem, the soil resistance at the site must be known or measured. MIL-HDBK-419 provides guidance on performing this measurement.

5.3.11 **Utilities availability.**

5.3.11.1 **Electric power availability.** The site survey team should determine the amount and quality of electrical power available to support the proposed or expanded site. Characteristics of existing primary and auxiliary power sources should be recorded. For established sites, a description of the power distribution system, to include the type of installed surge, high-altitude electromagnetic pulse (HEMP), and lightning protection, should be documented.

5.3.11.2 **Water supply.** Information must be obtained concerning the availability of water. If there is no local supply or if the supply is inadequate, an investigation must be made into methods of increasing existing capacity or finding new sources. The quantity of water required depends on the number of personnel operating and billeted at a site and normally should be included in the survey directive.

5.3.11.3 **Sewage disposal.** Existing sanitary facilities should be surveyed to determine if they are capable of receiving the projected additional waste. If an existing system can be used, the best entrance to the system should be established and the entrance depth below grade recorded. If the existing sanitary system is inadequate or if there is none, the best possible location for a septic tank should be established. The location and size of the area to be used for leach lines should also be determined. The proper design of a waste disposal system requires that a percolation test be performed and its data recorded. Local health department officials should be contacted to provide this information.

5.3.11.4 **Commercial gas supply.** Collect information on major suppliers of natural gas in the site locality. For each major supplier include: name and address, distance from the site to nearest pipeline, reserve capacity of the line, and other information deemed necessary by the survey approval authority.

5.3.11.5 **Administrative telephone service.** Information being collected should include type of supplier (military/commercial), distance to service connection, type of feeder/drop line, number of available pairs, cost estimates of line extension, and the capability of the local exchange to accommodate this site as well as any future site expansion.

5.3.12 **Power load.** For an existing site, the current facility load by usage/type should be recorded. The established site load (if any) and the projected new equipment requirements (see appendix C) will establish or modify the power load.

5.3.13 **Administrative and logistical support.** Support activities in the form of housing, transportation, maintenance, special equipment, administrative and finance services, family services, and availability and storage of petroleum, oil, and lubricants (POL) must be addressed. For existing sites or sites being established at a military installation, this information should be available through the local commander. For new sites at remote locations, the survey team should be tasked to collect this data.

5.3.14 **Nuclear survivability.** For surveys involving construction of new facilities, the project engineer should identify requirements to collect data relevant to nuclear survivability. For surveys involving the integration of nuclear-hardened equipment within an existing facility, detailed information on installed surge protection devices, shielding, and other pertinent areas must be collected during the site survey. Guidance for protection of telecommunications facilities from electromagnetic pulse (EMP) and high-altitude electromagnetic pulse (HEMP) can be found in the Defense Communications Agency (DCA) Command Center Design Handbook, Volume 2. In addition to guidance within the DCA handbook itself, this handbook lists several other references that might be useful in designing nuclear-hardened facilities. Appendix F, annex A worksheets, extracted from MIL-HDBK-412, give those data elements needed to complete the nuclear-hardened final design.

5.3.15 **Electromagnetic compatibility.** The survey team will not normally become involved in electromagnetic compatibility (EMC) measurements other than the collection of specific EMC data identified by the project engineer (and normally enumerated in the survey directive). The team leader shall ensure that team members who will be involved in these measurements are fully briefed during the presurvey phase.

5.4 **Site-specific data.** Site-specific data collection worksheets are contained in appendix F, annexes B through H. The appropriate site-specific annex and applicable annex A worksheets provide the base from which the data workbook is developed. Paragraphs 5.4.1 through 5.4.8 contain items for consideration.

5.4.1 **Microwave radio communications stations.** Microwave radio communications stations employ highly directional antennas transmitting at frequencies from roughly 0.2 to 40 gigahertz (GHz) although some satellite stations use even higher frequencies. Microwave radio stations fall into three basic categories: line-of-sight (LOS) stations, tropospheric scatter stations, and satellite earth stations. Although these types of microwave stations share some common characteristics, their different modes of operation require different approaches on the part of survey teams. Specific information for each type of site is contained in MIL-HDBK-416 (for LOS), MIL-HDBK-417 (for tropospheric scatter), and MIL-HDBK-412 (for satellite).

5.4.1.1 **General requirements for microwave stations.** Because of their wavelength and highly directional nature, microwave signals are strongly affected by obstructions in their path. Hence, during surveys of microwave sites, special attention must be given to the analysis of proposed signal paths. Paragraphs 5.4.1.1.1 through 5.4.1.1.11 contain items that should be considered. The importance of these items varies with the type of site (LOS, tropospheric scatter, or satellite) and the specific situation at that site; and the survey team should tailor the list accordingly.

5.4.1.1.1 **Antenna layout.** The proposed frequency range, and type, size, and number of antennas should be given in the survey directive so that area requirements may be determined and site layouts prepared with adequate clearances. Potential obstructions and the best corrective action (e.g., removing the obstruction, or reorienting or relocating an antenna) should be identified. The following should be taken into account during this analysis: radiation patterns of the antennas, great circle bearings, link distance between stations, and information on required horizontal and vertical clearances.

5.4.1.1.2 **Panoramic profile.** At each proposed site, a 360-degree horizon profile should be prepared from a point that commands the maximum visibility (this may or may not be at a proposed antenna location). The distance and vertical angles to significant points on the horizon (e.g., peaks, valleys, and changes of slope) should be recorded.

5.4.1.1.3 **Radio link horizon profile.** The survey team will perform horizon profiles as specified by the project engineer. The team leader must ensure that the members who will collect this data have been briefed during the presurvey phase and understand the requirements. Horizon profiles are especially important for tropospheric scatter stations, and for satellite earth stations that must track satellites whose orbits are viewed relatively close to the horizon.

5.4.1.1.4 **Path profile.** For each proposed radio link, the team should have available path profiles (normally made during the presurvey phase) with appropriate height scale, distance scale, and earth radius factor. Profile details should be verified and adjusted as necessary based on on-site observations. The team should be prepared to construct path profiles for radio links not previously considered or for which data were not provided.

5.4.1.1.5 **Path clearance.** Because of their highly directional nature, microwave signals are particularly vulnerable to obstructions in or near their signal paths. Calculation of clearance requirements for microwave signals can be quite complicated (detailed instructions for making these calculations can be found in MIL-HDBK-416 and MIL-HDBK-417). The survey team should not normally have to make these calculations, but will be asked to check for all potential obstructions in specific areas. These include: (1) the area from the antenna out to the beginning of the far field of the signal path (see 5.4.1.1.5.1a) and (2) within the far field, at key points identified by the project engineer (see 5.4.1.1.5.1b). The team leader must ensure that these areas have been identified during the presurvey phase.

5.4.1.1.5.1 **Data on obstructions.** For the areas specified above, the survey team should gather detailed information on anything that could obstruct the proposed signal. If it is feasible to remove an obstruction, record this fact. If it is not feasible to remove the obstruction, and there is no doubt that it renders the site unusable, an alternative location for the site will have to be found (see 5.4.1.1.5.2).

a. For the portion of the path out to the beginning of the far field, make a detailed profile of the signal path. This should consist of an annotated sketch showing the location, height, other appropriate dimensions, and prominent characteristics of all trees, buildings, towers, or other potential obstructions.

   NOTE: The portion for which this detailed profile must be provided extends outward from the antenna (in the direction of the signal beam) for a distance equal to twice the antenna diameter squared divided by the operating wavelength, where both the diameter and wavelength are expressed in the same unit of measure. If there is any question as to the distance for which the detailed profile is required, consult the project engineer.

b. For the remainder of the path, clearance requirements are governed by the Fresnel zones for the proposed link. These zones form cigar-shaped envelopes in the space surrounding the direct beam of the signal, within which penetrations may obstruct the signal (see note below). Such obstructions are most likely to occur where elevation brings the surface of the earth within a certain distance of the signal path. This means that the survey team must investigate specific hilltops, ridges, and other relatively high ground where obstructions are likely to occur. An engineer should identify these areas and mark them on the path profile (see 5.5.1.1.4) during the presurvey phase. During the survey phase, the team should check these areas for trees, buildings, and other potential obstructions. If the project engineer requires, the survey team should also verify altitudes of terrain features (an altimeter or transit may be used). All information gathered on elevations and potential obstacles should be recorded on the path profile.

NOTE: The normal requirement for Fresnel zone clearance is that the axis of the antenna beam be separated from potential obstructions by a distance equal to not less than 0.6 of the radius of the first Fresnel zone. (See MIL-HDBK-416 and MIL-HDBK-417.)

5.4.1.1.5.2 **On-site calculations.** Sometimes on-site calculations cannot be avoided. For example, the original proposed location of a site, for which path profiles have been prepared and for which key areas to be checked have been identified, might be found to be unusable. In such case, the survey team should investigate alternative locations. These alternatives, of course, must be checked to see if they meet clearance requirements, which must then be calculated (over the entire length of all proposed paths). For this reason, ideally, the site survey team should include among its members a microwave engineer. In any event, the team chief should ensure that copies of MIL-HDBK-416 (for LOS sites) or MIL-HDBK-417 (for tropospheric scatter sites) are available to the on-site team.

5.4.1.1.6 **Topography.** A topographic sketch should be made of the site and nearby terrain features that might adversely affect radiation patterns. The sketch should include (but not be limited to) nearby forests and other types of vegetation (including even relatively sparse desert vegetation); bodies of water; relief features such as hills, ridges, and valleys; and buildings. This information should also be recorded on the topographic data worksheet in appendix F, annex A.

5.4.1.1.7 **Isolation requirements.** Care must be exercised in the location of microwave stations and the positioning of antennas. Important considerations are as follows:

a. Locating antennas in a manner that restricts personnel from exposure to excessively high levels of electromagnetic energy. In addition to radio frequency (rf) radiation, all microwave systems have some amount of ionizing (X-ray) emission. The acceptable limits for personnel working in such an area is 2.0 milliroentgens (mr) in any hour or 100 mr/week. Additional data are contained in MIL-STD-454.

b. Limiting rf power density incident on existing or planned fuel or explosive storage areas to acceptable limits as stated in AFM 127-100.

c. The proximity of the proposed site to major sources of electromagnetic interference (EMI), such as electrified railways or industrial areas. Existing or planned potential sources of radio frequency interference (RFI) should be investigated and documented for each site. The only practical method for identifying RFI sources is by taking on-site measurements, then locating the troublesome emitter(s). Many RFI sources might not be constant emitters; therefore, measurements may take hours or even days to ensure all sources have been monitored. Government and local civilian (amateur radio) frequency coordinators can help identify and locate licensed emitters. RFI can also result from the absorption, rectification, and reradiation of rf power that originated from existing site transmitters. Metal fences, electrical transmission lines, buildings, and nearby natural features such as rock ledges and cliffs, can cause noise in receiver systems either from back-scatter or reradiation. If the site survey team lacks the equipment, technical expertise, or time to perform required RFI measurements, the appropriate engineering agency should be tasked for assistance. The location of nearby power lines, roads, hospitals, industrial centers, electrified railways, and other sources of electrical noise should be shown graphically in the site survey report.

5.4.1.1.8 **Interconnecting communications.** Interconnection between a microwave terminal and system users (subscribers, circuit switches, or technical control facilities) can be established by cable or LOS radio. For new installations, the on-site survey team should verify the technical feasibility of the presurvey choice and ensure that it is the least costly. For established sites, the team should verify whether existing facilities can be expanded or rerouted rather than establishing new interconnection links.

5.4.1.1.9 **Towers.** Data on existing site towers are required before construction plans can be finalized. These data should include:

a. Location, type (e.g., guyed, metal free standing, etc.), and height of tower.

b. Location, transmission path azimuth, size, power output, and operational frequency for each installed antenna.

c. Location on the tower of possible LOS antenna additions and the permissable transmission path azimuth limits for each.

d. Results of stress studies on towers to ensure they will meet the twist and sway and other safety requirements contained in MIL-STD-882.

e. Location and type of safety climbing devices, lightning protection devices, and requirements for obstruction lighting. If it is necessary for any member of the survey team to climb towers or poles, the safety precautions given in TO 31-10-3 shall be observed.

5.4.1.1.10 **Storage of petroleum, oil, and lubricants.** Record the location and type (e.g., gasoline above or below ground) of all existing storage areas for petroleum, oil, and lubricants (POL).

5.4.1.1.11 **Technical guidance.** It is recommended that a microwave engineer serve as a member of the site survey team. In the event the team does not include such a qualified person, detailed guidance pertaining to maximum permissable horizon (vertical) angles and path distances should be provided for the team members.

5.4.1.2 **Line-of-sight stations.** Line-of-sight (LOS) installations provide point-to-point multichannel linkage between fixed and semifixed telecommunications facilities. Generally, links are established using microwave carrier frequencies, but when required, the lower ultra high frequency (UHF) and the very high frequency (VHF) spectra are used. Individual links typically range from 6 to 60 mi (10 to 100 km), use highly directional antennas, and low (typically 0.1 to 10 W) transmit power. LOS antennas range from 18 in. (0.5 m) to 12 ft (3.7 m) in diameter and are seldom installed at heights exceeding 120 ft (36.6 m) above ground. Multilinked systems, through the use of drop-and-insert multiplexed or baseband repeater sites, can provide system services over great distances. Although not as restrictive as tropospheric scatter stations or satellite earth stations, the radiated power density of LOS installations must be considered when planning antenna locations. MIL-HDBK-416 provides detailed instructions for microwave LOS systems. The design criteria for LOS stations are similar (though not identical) to those for tropospheric scatter stations, allowing common use of data worksheets. (See appendix F, annex B.) Special care must be exercised in selecting the location of an LOS station. Usually, situations can arise when the survey team must look for alternative locations. For example, new construction near the originally proposed location can render it unusable. In such a case, the team should gather information on alternative locations. In choosing alternative locations to investigate, the survey team shall consider only locations that meet the signal path requirements established for the original location.

a. The proposed location must have LOS with other sites to which it will be linked. To check for LOS, construct a path profile (see 5.4.1.1.4) for each proposed link. Use the standard condition $K = 4/3$. If the site does not meet LOS requirements, it should be given no further consideration.

b. The new location must be within a certain distance of sites to which it will be linked. This distance will be established by the project engineer and is based upon his calculation of the basic propagation loss (BPL). While the survey team need not know the value of the BPL, it should know the maximum permissable distance between sites, which is based on the BPL. Before gathering further information on a location, check the distances of all links to other sites. If any one is too great, look for another location. Otherwise, record the distances and continue the survey.

5.4.1.3 **Tropospheric scatter stations.** The most dominant feature of a typical tropospheric scatter station is the size of the antenna system, which can range from 8-foot (2.44-meter) inflatable or fixed parabolic dishes to the huge 120-foot (36.6-meter) billboard style reflectors. The size and complexity of an installation depends on the allocated frequency, gain requirements (due to path losses), environmental conditions, and mobility needs. The high-power transmitters used by tropospheric scatter communications limit where the antennas can be placed within a site. MIL-HDBK-417 provides complete instructions for system and facility design of tropospheric scatter stations. Appendix F, annex B, contains specific data worksheets. Should it become necessary for the survey team to evaluate a previously unconsidered site, the instructions in appendix D can be used to make a quick check of the feasibility of the new location.

5.4.1.4 **Satellite communications earth stations.** Satellite earth stations have much in common with tropospheric scatter and LOS microwave installations. Common features include sensitive receivers, high gain antennas, and high rf output power density. Because of their strategic or tactical importance, satellite terminals must be protected to a greater extent than most other communications installations. Special techniques are used to increase the station's nuclear and physical survivability. MIL-HDBK-412 contains guidance for surveys of satellite earth stations. In establishing the azimuth and length of the baseline, the elevation of the site, the location of the reference markers, and similar survey information, third order accuracy (1 part in 5,000) should be maintained. Data collection worksheets are the same as those used for LOS and tropospheric scatter sites (appendix F, annex B).

5.4.2 **High frequency transmitter stations.** Depending on the number of antennas and type of service required, a high frequency (HF) transmitter site can range in size from less than an acre to tens of acres. The design and site selection criteria for HF transmitter sites are presented in MIL-HDBK-413. Specific data worksheets are contained in appendix F, annex C, of this handbook. Computer modeling of system parameters such as antennas, power options, and frequency assignments are available to aid in HF site development. Since ground wave propagation is seldom employed at HF frequencies (except for occasional tactical use), the following discussion concerns only sky wave propagation. The foremost criterion for selecting an HF transmitter site is its suitability for the efficient radiation of radio signals. The location of nearby manmade or natural objects that infringe upon the induction field can adversely affect antenna radiation patterns. Paragraphs 5.4.2.1 through 5.4.2.8 contain important factors in surveying HF transmitter sites.

5.4.2.1 **Vertical antennas.** Vertically polarized antennas are well suited for ground wave service in the lower part of the HF spectrum and for low-angle sky wave radiation throughout the entire spectrum. Such antennas produce intense rf ground currents under the antenna structure. These ground-conduction rf currents can dissipate much of the available transmit power unless an effective ground return system is installed. Ideally, such a ground system would consist of a solid metallic sheet with infinite dimensions placed under the antenna. Standard practice is to install a 'ground plane' consisting of 120 radial wires equally spaced 3 degrees apart. These radials should be at least a quarter-wavelength long at the lowest frequency used. Radials may be buried for protection from vehicular or other damage.

5.4.2.2 **Horizontal antennas.** Horizontally polarized antennas do not require a ground plane. They exist in a great variety of designs and dimensions. The simplest is approximately a half-wavelength long and only a very small fraction of a wavelength in width. The more complex designs can encompass many wavelengths of space for both length and width. The conductivity of the ground under horizontal antennas has less effect upon the strength of radiated signals than in the case of vertical antennas.

5.4.2.3 **Antenna size, siting, and spacing.** The area required for a transmitting site depends primarily on the type, operating frequencies, and number of antennas. Because mutual coupling between antennas is a function of radiation azimuth and spacing, the required size and shape of a site cannot be standardized. Criteria for laying out an antenna field are contained in FM 11-65. When HF transmitting antennas must be oriented so that their radiation paths cross, the antennas must be located so that their point of convergence is more than 1000 ft (300 m) in front of either antenna. Once antenna siting and spacing have been determined, incorporate the results into a detailed antenna field sketch.

5.4.2.4 **Site isolation requirements.** Isolation requirements for an HF transmitter site are given in table I.

TABLE I. Isolation requirements for HF transmitters.

Activity	Ideal distance mi (km)	Minimum distance mi (km)
Transmitter site to technical control center	1.0 (1.6)	0.0
Transmitter site to inhabited area	2.0 (3.2)	0.5 (0.8)
Transmitter site to industrial area	5.0 (8.0)	2.0 (3.2)
Transmitter site to airfield	5.0 (8.0)	3.0 (4.8)

NOTE: The distances given in the above table should not be construed as absolute limits or criteria. They are furnished only to give a general appreciation of the separation required and may be used in the preliminary phase of site evaluation and selection. Actual separation requirements are a function of the receivers, antennas, power, and topography involved and should be treated on a case-by-case basis.

5.4.2.5 **Horizon profile.** From a position established as the center of the antenna field, a series of manual observations should be made to depict a 360-degree horizon profile. A theodolite or surveying transit, referenced to true north (via the site reference baseline), can be used to read vertical angles to the horizon. Vertical angles to obstructions should be recorded to the nearest minute, and the distance to nearby objects should be indicated. The geodetic coordinates of the surveying instrument station must be recorded. This allows shifting of the horizon plot should the reference azimuth change significantly after a final baseline determination.

5.4.2.6 **Ground conductivity.** The measurement of the ground conductivity at HF frequencies is generally beyond the capability of site survey teams. However, a subjective rating can be made by placing the site in one of the categories listed in table II.

TABLE II. Ground conductivity for HF propagation.

Type of surface	Relative conductivity
Sea water	Good
Fresh water	Fair
Soil	Fair
Rocks	Poor
Desert	Poor
Jungle	Very poor
Arctic	Very poor

5.4.2.7 **Interconnecting communications.** Interconnection between an HF transmitter site and its traffic control facility can be established by cable or LOS radio. For new facilities, the on-site survey team should verify the technical feasibility of the presurvey choice and ensure that it is the least costly. For existing sites, the team should verify whether existing links can be expanded or rerouted to provide needed service. See 5.4.1.2 (for LOS) or 5.4.4 (for cable) for required data collection elements.

5.4.2.8 **Interference.** The establishment of an HF transmitter site can raise a number of EMI/RFI problems. In general, HF transmitters are more likely to be the cause of RFI/EMI than they are to be the victims. Because of (1) the high power density in the immediate vicinity of HF transmitters and (2) the combined coverage of the ground wave and the sky wave, the interference effects of HF transmitters can be felt both nearby and at a greater distance. The distant interference effects can be minimized by proper channel utilization; such utilization is a result of proper frequency management coordination. The survey team, however, will be concerned only with nearby or on-site interference, both that caused by the HF transmitter and that experienced by the transmitter. Such interference can be minimized by careful site selection and antenna layout. Examples of such nearby interference include the following:

a. Interference introduced into the HF transmitter's traffic or keying lines by nearby high-powered radar sites or other pulse-type emitters.

b. Intermodulation between collocated or nearby HF transmitters.

c. Interference with certain kinds of nearby electronic devices and rf equipment. Equipment used by the interconnect communications facility (ICF) for the site, because of its proximity to the HF transmitter, can be vulnerable to interference. For example, the HF signal can introduce noise into the intermediate frequency (IF) amplifier of a microwave receiver used by the ICF.

5.4.3 **HF receiver stations.** In general, the same criteria given for HF transmitter stations also apply to HF receiver stations. Since receiving does not involve large amounts of power, there are no restrictions concerning path convergence among the site antennas. However, placement must preclude interactive coupling between adjacent antennas. Specific data worksheets are the same as those used for HF transmitter sites and are contained in appendix F, annex C.

5.4.3.1 **Receivers collocated with transmitters.** When necessary, receivers can be collocated with their companion transmitters. Collocation requires that steps be taken to minimize interference or desensitization of receivers. Such steps include installing the antenna field so as to provide minimum coupling between transmit and receive antennas. When possible, companion receiver and transmitter sites should be physically separated.

5.4.3.2 **Site isolation requirements.** Isolation requirements for HF receiver sites are given in table III.

5.4.3.3 **Radio interference.** Facilities, existing or planned, which can be potential sources of RFI and EMI, should be investigated and documented for each site being evaluated. Possible sources of RFI and EMI include the following:

a. Radar transmitters.

b. Navigational aids.

c. Commercial AM, FM, and television broadcast stations.

d. Commercial and noncommercial communications systems.

e. Industrial centers.

f. Major highways and electrified railways.

g. Hospitals.

h. Electric power lines and power generating sources.

i. Police, fire, and state and local government buildings.

j. Airports, including approach and departure flight paths.

TABLE III. Isolation requirements for HF receivers.

Activity	Ideal distance mi (km)	Minimum distance mi (km)
Receiver site to transmitter site		
(1) Under 1 kW	6.2 (10.0)	0.0
(2) 1 kW and over	20.0 (32.0)	5.0 (8.0)
Receiver site to aerial power line		
(1) Below 15 kV	1.0 (1.6)	0.2 (0.3)
(2) Above 15 kV	5.0 (8.0)	3.0 (4.8)
Receiver site to industrial area	10.0 (16.0)	5.0 (8.0)
Receiver site to major highway	2.0 (3.2)	1.0 (1.6)
Receiver site to rural road	1.0 (1.6)	0.2 (0.3)
Receiver site to inhabited area	5.0 (8.0)	2.0 (3.2)

NOTE: The distances given in the above table should not be construed as absolute limits or criteria. They are furnished only to give a general appreciation of the separation required and may be used in the preliminary phase of site evaluation and selection. Actual separation requirements are a function of the receivers, antennas, power, and topography involved and should be treated on a case-by-case basis.

5.4.3.4 **Tests and measurements.** Not all possible sources of RFI and EMI can be determined from visual observations or local record checks. Some locations are inherently less usable as receiver sites due to uncontrollable noise at rf frequencies. Therefore, to ensure a high probability of success with a new receiving station, adequate tests and measurements must be performed at candidate sites. High levels of atmospheric noise prevailing from early spring to late fall make it difficult to perform accurate measurements of noise from local sources. However, if a proposed site is located in the rf beam of a local noise source, the overall noise reading will be even higher. Thus, the measurements will still be useful in choosing between proposed sites.

a. Meaningful noise measurements require several days, special equipment, and technical expertise. If the equipment and technical expertise are not available, contact the appropriate engineering agency for assistance.

b. Permanent record measurements should be made of noise levels at all sites. These measurements can be used in system performance analysis to determine the relative performance at each site. Noise measurements also provide baseline data to determine if noise levels have increased and corrective action is required.

5.4.4 **Interconnect communications facilities.** The purpose of an interconnect communications facility (ICF) is to provide interconnecting communications between physically separated system users. An example would be the linkage between an HF technical control facility (TCF) and its transmitter and receiver site(s). These communications include data (analog or digital), signaling, and other system controls. An ICF survey can be performed either concurrently with the design of the supported system, or separately, if part of an upgrade or expansion. ICF media are either LOS radio (see 5.4.1.2 and appendix F, annex B) or cable (see following paragraphs and appendix F, annex D). For satellite systems, the ICF is the communications link between the earth terminal complex (ETC) and the TCF. The four basic configurations for this ICF, as defined in MIL-HDBK-412, are as follows:

a. Configuration 1: The ETC is connected to the TCF by multiple baseband cables or fiber optic bundles.

b. Configuration 2: The ETC is connected to the TCF by LOS radio.

c. Configuration 3: The ETC and TCF are in the same building and are interconnected by cables.

d. Configuration 4: The ETC and TCF are in separate buildings and are interconnected by cables.

5.4.4.1 **Underground cable installation.** Underground conduit and manhole systems should be the first consideration for cable installations in areas where such systems are available. Utilization of existing conduit is preferred.

5.4.4.2 **Buried multipair cable.** In the past, most of the longer ICF cable runs were of the aerial type. Buried ICF cables were normally reserved for intrasite use or other areas of high congestion. Improvements in cable construction and the overall long-term cost reduction and reliability associated with buried design have made it the preferred cable-laying technique. Paragraphs 5.4.4.2.1 through 5.4.4.2.4 discuss some of the field survey data collection requirements for evaluating a buried cable design.

5.4.4.2.1 **Route selection.** The route of the proposed cable run should be designed to provide the most direct path. When selecting the final route, consideration should be given to trenching conditions and the cost of repaving streets and sidewalks. Route selection can also be influenced by security requirements and easement problems.

5.4.4.2.2 **Measurements.** Horizontal measurements should be made with a transit, a steel tape, or a steel chain. Vertical measurements can be made with a transit or a stadia rod and hand-held clinometer. A profile plot (see figure 2) of the proposed cable run should be prepared from recorded linear and vertical measurements.

5.4.4.2.3 **Field notes.** Following are some of the items that should be observed and graphically recorded in the survey workbook:

a. Cable terminal locations.

b. Proposed cable route.

c. Route ownership.

d. Street or road name, or highway number.

e. North arrow.

f. Landmarks such as railways, pipelines, bridges.

g. Location of underground obstructions such as electric feeds, water and gas pipelines.

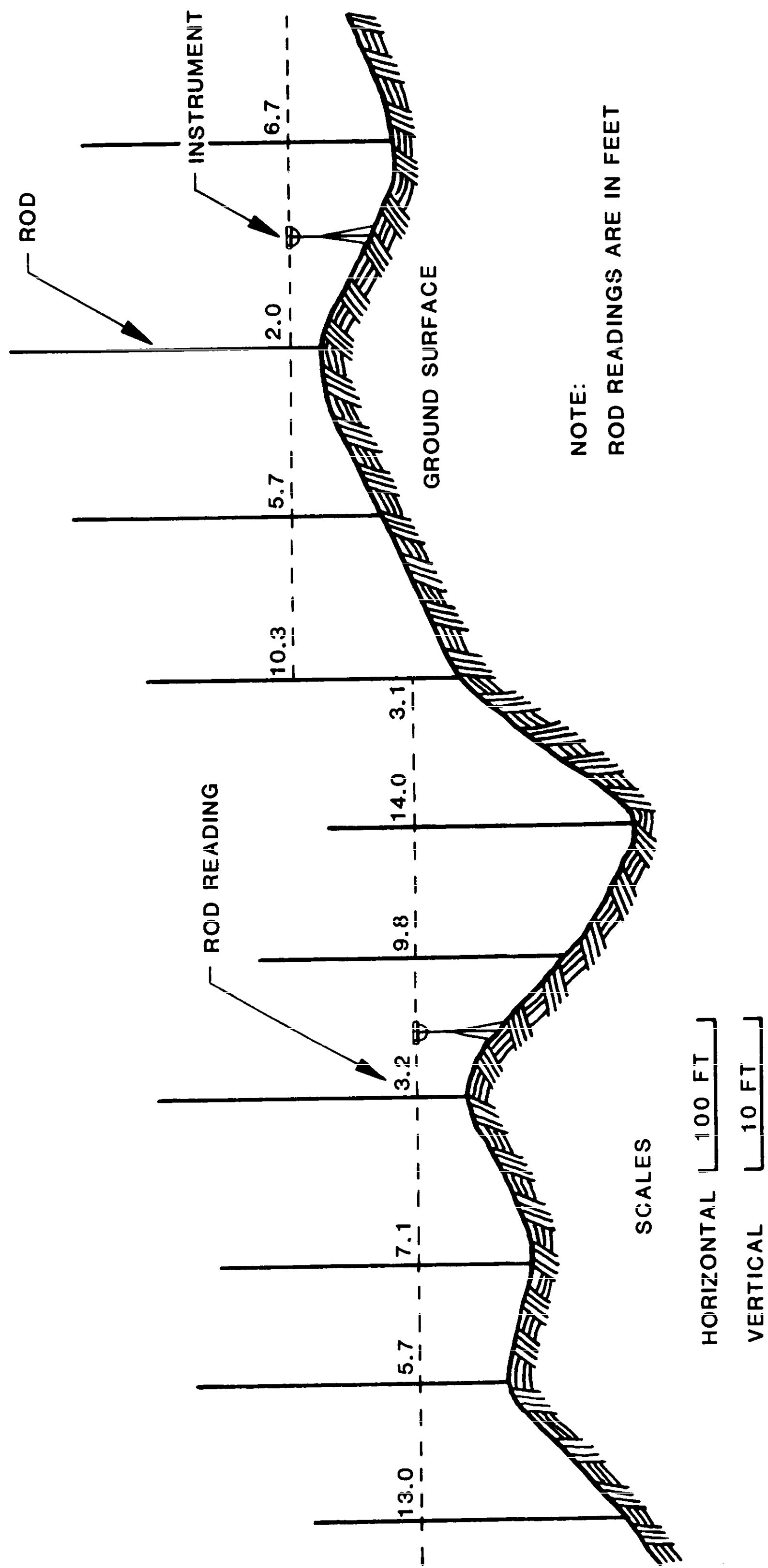


FIGURE 2. Profile plotting.

h. Physical barriers (above ground).

i. Location and types of street and driveway paving.

j. Linear distances along the proposed route of cable run.

k. Manhole numbers, distance between manholes, and identification of manholes in which repeaters are located.

l. Number of ducts in conduit runs, number of ducts vacant, and diameter of all ducts.

5.4.4.2.4 **Right-of-way.** The survey team must determine ownership of the land proposed for the cable route. Record this information on the real estate worksheets.

5.4.4.3 **Aerial multipair cable.** Aerial cable installations are vulnerable to lightning and costly to install and maintain. Except for short intrasite routes, this installation method should be avoided. Should an aerial cable installation be required, data collection requirements are contained in FM 11-486-5.

5.4.4.4 **Coaxial cable.** Coaxial cable installations entail nearly the same requirements as multipair cables. The major difference, except for short cable runs, is that repeaters or line amplifiers are required. Repeaters and line amplifiers must be installed with access for maintenance and repair.

5.4.4.5 **Fiber optic cable.** For ICF designs incorporating fiber optic linkage, see 5.4.6.

5.4.5 **Submarine cable terminals.** The location of a submarine cable terminal is dictated by the required end-destination of the cable route. The location indicated in the presurvey may need to be changed if the on-site survey team finds it unsuitable. If the shift in location is great, the cable end-routing may have to be adjusted to conform to the new terminal siting. Appendix F, annex E, contains the specific site worksheets.

5.4.5.1 **Onshore communications interconnect.** Since submarine cable systems normally are used to provide trunk circuit service between separated communications networks, the proximity of the submarine terminal to the nearest point-of-entry into the onshore communications system is of importance. The terminal itself needs to be located close to the shore for three reasons. First, because cable hazards are greater on land than under water, any reduction in the shore routing reduces the chance of outage. Second, since submarine cable grounds carry power for cable repeaters, the possibility of accidental contact with dangerous potentials is reduced. Third, near-shore locations are the most economical choice for obtaining the low resistance earth electrode connection required by submarine cables.

5.4.5.2 **Cable landing.** Landings should not be made in close proximity to other submarine cables. At least 100 ft (30 m) should separate adjacent cables at the shore landing site. A minimum horizontal spacing of five times the water depth should be maintained to permit grappling operations for servicing or repair of repeaters and cable sections. Landings should be made, ideally, at sandy beaches with a medium slope. Shallow beaches that extend out a considerable distance from the shore cannot be negotiated by cable ships, and require that other cable-laying techniques be employed. These shallow areas should be described in detail. Copies of coastal or harbor charts with good detail should be obtained and should be provided as part of the presurvey data. Rock, coral, and underwater shelves will cause rapid damage to cables if preventive measures are not taken. Underwater trenches can be constructed and filled with sand to protect cable approaches. Sharp inclines at the shore should be avoided because they present special problems for support and protection of splices. In areas where beach ice is encountered, the cable must be armored or otherwise protected and buried below the depth affected by ice scour. Avoid placing cable landing sites in fishing grounds, ship anchorages, and locations having heavy ocean currents. Contact appropriate government agencies to obtain hydrographic charts of winter ice conditions and ocean currents of the intended landing sites.

5.4.5.3 **Offshore and land profiles.** The extent to which the offshore profile should be investigated is difficult to determine during presurvey operations unless the site is already an established cable landing area. Decisions in this area are normally left to the discretion of the on-site survey team. The land profile should show all obstructions that could affect cable routing. If it is possible to locate the terminal building near the shore, the land profile may be combined with the beach profile drawing.

5.4.5.4 **Beach profile.** The beach profile is a small scale drawing showing the shore approach from both water and land. The profile should include fine detail of water and land obstructions and indicate the approximate high- and low-tide boundary lines.

5.4.5.5 **Landing site features.** If previously collected information on the proposed site is available, a complete narrative description of the landing site should be given. This description should include geological formation, soil formation, topographic features, and information on tides, currents, and ice formations. If the services of military divers are available during the on-site survey effort, a detailed investigation of the underwater approach should be made.

5.4.5.6 **Land cable route.** If the cable is to be routed on property not currently under control of the installation authority, the site survey team must collect sufficient data to allow determination of whether to buy, lease, or obtain an easement on the land in question.

5.4.5.7 **New terminal buildings.** Construction design of new submarine cable terminals should, as much as possible, disguise and safeguard their intended use. The availability of utilities should be considered in the selection process.

5.4.6 **Fiber optic communications.** Fiber optic cable can be used for both analog and digital communications. Installation is very similar to coaxial cable links. Specific data collection worksheets are in appendix F, annex F.

5.4.6.1 **Inside plant.** Inside plant fiber optic installation is primarily concerned with rack mounting of terminal equipment. Generally, equipment will be configured in standard 19-in. (48-cm) equipment rack bays. However, many items of commercial equipment are configured for 23-in. (58-cm) racks. The project engineer should know the size of the equipment to be installed. The equipment racks and bays contain space for mounting fiber optic transmitters and receivers and ancillary equipment. The location of fiber optic terminal equipment should be at least 3 ft (1 m) from strong magnetic fields and sources of impulse noise. The bays should be installed with access provided to front and rear. Normal telephone office lighting and ventilation are adequate for fiber optic terminals.

5.4.6.2 **Outside plant.** Conventional outside plant cable installation techniques are applicable to fiber optic cable installations. Outside plant installation is addressed in FM 11-372-2/TO 31W3-10-12. The major differences between metallic and fiber optic cable installation are that fiber optic cables require the monitoring of pulling tension, do not tolerate bends with radii smaller than a specified minimum, and permit greater spacing of repeaters. For specific details on fiber optic cable installation, see MIL-HDBK-415.

5.4.7 **Switching centers.** Circuit and message switches can be either system dedicated (connected to users through trunks only) or capable of servicing both trunks and user drops. Initial installations and most upgrading of switching centers are both costly and labor intensive. Specific site data worksheets are contained in appendix F, annex G.

5.4.7.1 **System dedicated switches.** When performing a site survey for DoD telecommunications centers such as AUTOVON or AUTODIN installations, it is assumed that the survey effort does not include any aspect internal to the switch. Rather, the survey will consist of collecting and evaluating data needed to select a particular installation site. The data to be collected and evaluated consists mainly of common data. Any nonstandard requirements, such as nuclear hardening or extraordinary TEMPEST requirements, should be addressed by detailed instructions in the survey directive.

5.4.7.2 **Nondedicated switching centers.** Fixed circuit and message switches are specifically tailored to meet individual command requirements. Heavy reliance on commercially provided long-haul telecommunications has dictated the procurement and use of existing (off-the-shelf) commercial network switching equipment. Transportable (standard type-classified) switching centers are primarily designed for tactical use. Should these switching centers be used for semifixed operations, increased reliability can be obtained by replacing the tactical (palletized) power with a more reliable military or commercial source. Interface capabilities, space, and power requirements for nonstandard and standard switching equipment can be obtained from applicable military technical manuals or manufacturer's manuals. With existing facility expansion or upgrade, outside plant cable fill should be examined to ensure that sufficient capacity exists to support the installation.

5.4.8 **Local area networks.** Local area networks (LANs) are finding increased use at both large and small installations. The advantages afforded by rapid information transfer and multiple data base access will continue to advance this flexible communications media. Appendix E contains a short tutorial on the salient features for each of the main LAN architectures. Information needed consists of the amount and type of nodal equipment, cable run measurements by type of installation, and the number and type of repeaters needed. Also required is a detailed network diagram showing the location of nodal equipment and repeaters. Appendix F, annex H, contains specific data collection worksheets. Worksheets from appendix F, annex D or F, as appropriate, can also be used on large LAN projects.

5.5 **Site evaluation.**

5.5.1 **General.** The site selection process can range from obvious choices to complex many-faceted decisions. No easy formula exists that can be applied to any and all site selection issues. Sites deemed to be ideal telecommunications locations are often found to be nonavailable, too costly to build, or unfeasible to support. Paragraphs 5.5.2 through 5.5.10 discuss some of the factors used in the site selection process.

5.5.2 **Long-range system requirements.** System integrity is of prime importance. Selected sites must be capable of establishing or maintaining current and future requirements as specified in the system documentation.

5.5.3 **Communications suitability.** A selected telecommunications site must be capable of supporting the established system standards. The site must pass or terminate desired signals while meeting or exceeding required grades of service. Costs and construction effort required to establish or expand the site will impact on the total site suitability.

5.5.4 **Availability of land and facility.** A site is valueless unless it can be made available in time to meet the program schedule. The approximate site availability date should be determined during the site survey. An alternate site should be sought if it appears the primary site might not be available in the time required.

5.5.5 **Topographic and geophysical considerations.** The topography and environment are key factors for sites with rf emitters. Mountainous terrain can entail special siting and excavation problems. Severe weather conditions (temperature extremes and precipitation) greatly influence the type of equipment installed, the type of construction, and the cost of maintaining a site.

5.5.6 **Electromagnetic and radio frequency interference (EMI/RFI).** Reports of EMI/RFI sources that could degrade facility performance should be evaluated as to their effect on site suitability and coordinated with the local frequency manager.

5.5.7 **Easements or modifications to adjacent properties.** Easements or modifications often must be made to adjacent properties to make a site fully functional. Trees may have to be removed, access roads constructed, and power and signal lines installed. Sites at which future expansion is readily possible should be rated higher in the selection process than similar sites with no expansion capability.

5.5.8 **Economics.** When a budget is established for a telecommunications system, it usually contains discrete allocations for each site. Very often, facts uncovered during the site survey show that the cost of a site will exceed the budget allocation. If there are no suitable alternate sites, the cognizant authorities should be made aware of the need for additional funding. There are a number of variables that can seriously affect total site costs. The one that generally presents the greatest problem is site access. Although an access road has no affect on the communication suitability of a site, it can be one of the largest single cost items. Weather conditions at a site will also have an influence on construction costs. A severe winter means a limited construction season, necessitating costly overtime and the possible extension of the construction over several seasons. Extreme heat, heavy rain or snowfall, or other chronic bad weather have a profound influence on the economy of the site. Although the basic function of the system is to communicate, economic factors must be considered, especially if a fixed budget has been established.

5.5.9 **Construction cost estimates.** For assistance in estimating construction costs, the site survey team should use DoD and Military Construction Pricing Guides, pricing manuals and cost data published by private industry, and cost estimates developed by local design and construction agencies. A valid cost estimate of the work to be accomplished is an integral part of the final site survey report.

5.5.10 **Support and logistics.** When located on or near a major military installation, new or expanded sites have minimal effects on local support and logistics agencies. Remotely located sites present additional support problems and costs that should be considered in the selection process.

6. KEY WORD LISTING

fiber optic communications

interconnect communications facility

local area network

power, electric

radio frequency interference

radio station, high frequency, receiver

radio station, high frequency, transmitter

radio station, microwave, line-of-sight

radio station, microwave, tropospheric scatter

satellite earth station

site survey

submarine cable terminal

switching center

APPENDIX A. SURVEY REPORT CHECKLIST

10. **Project description.** A narrative description of the proposed or expanded telecommunications facility.

20. **Site information.**

a. The site coordinates and the narrative location with regard to nearby military installations, communities, or prominent terrain features.

b. Main highways, existing site access roads, or the proposed location of, and real estate required to construct, new access roads.

c. Any restriction on future expansion or construction in the vicinity of the site.

d. Real estate acquisition requirements if the site is not on Government-owned property. If Government-owned, identification of the agency exercising jurisdiction or ownership.

e. Problems involving water, mineral and access rights, restricted access, and sewage disposal. Recommendations for studies of soil, water, sewage disposal, power, and roads.

f. Restrictions on antenna size, placement, and type; Fresnel zone clearance requirements for new and existing antennas.

30. **Supporting structure information.**

a. The specific construction or building modifications that must be completed before equipment installation can begin.

b. The voltage, frequency, number of phases, and capacity of primary and auxiliary power. The number of new power distribution circuits needed, ranked by circuit breaker rating. If required, the number of, and specifications for, generators, power inverters, frequency converters, and other special power source equipment.

c. Heating, air-conditioning, and other specific services and utilities, including new facilities or modification of existing facilities, needed to support the new requirement. Temperature and humidity ranges, and expected heat gain or loss in British thermal units (Btus), will be specified.

d. Construction or improvements needed in the earth electrode subsystem.

e. Expected electromagnetic radiation hazards and recommendations for minimizing these hazards and posting warnings.

f. Requirements for, and availability of, POL.

g. Requirements for obstruction and hazard lights. Locations and heights of existing or proposed antenna structures should be shown on a drawing. The location of emergency helipads and existing or proposed flight path(s) should also be shown.

h. Existing telephone plant and requirements for new construction needed to upgrade service.

i. If the facility will be used for secure operations, a statement of coordination with appropriate local security agency.

j. Requirements for cable trenching and sand and gravel fill; surfacing of roads and sidewalks; restoration of grass or reforestation; and sealing or resealing of walls, roofs, and cable entrances disturbed during installation.

40. **Drawings and maps.**

a. A reproducible area layout and contour map showing the selected site and the required area (clearance and easement) boundaries. This should be a current map showing projected building, facility, and utility construction. The relationship of the selected area to existing military or civilian facilities must also be shown.

b. Floor plans and building elevation drawings of the proposed facility; if the facility is to be located in an existing building, obtain drawings of the area designated for new equipment.

c. A road map of the area showing main highways, communities near the site, and the route of the proposed access road.

d. Drawings and layouts for facility auxiliary structures such as antenna towers and supports, cable duct systems and manholes, and security fences.

e. Emergency helipads and existing or proposed flight path(s).

50. **Report processing.**

a. Identify the site survey participants. Give telephone numbers for point-of-contact within the agencies involved.

b. Identify the channels to be followed in coordinating the report, with appropriate suspense dates.

c. Identify the agencies tasked to provide missing information and the dates by which each action must be completed.

d. List any objections of the civil engineer or construction agency, such as lack of utilities or local construction materials. State whether the facility has been included in the area master plan, or give the date the planning board will meet to consider its inclusion.

e. Include a statement of concurrence or nonconcurrence from each reviewing organization. Statements of nonconcurrence must include rationale supporting nonconcurrence.

APPENDIX B. FACILITIES CRITERIA

10. **Compatibility.** All new facility construction should conform to the existing or proposed architectural style for the area.

20. **Type of construction.** Communications facilities shall be of the type 'N' noncombustible construction (see AFM 88-15). The principal difference between the three classes of type 'N' construction, as identified below, is the duration of fire resistance.

20.1 **Fire-resistive construction.** Construction in which the structural elements such as walls, partitions, columns, piers, beams, trusses, floors, and roofs are of noncombustible materials with fire-resistive ratings in terms of hours (as specified in AFM 88-15).

20.2 **Protected noncombustible construction.** Construction in which structural members, including walls, partitions, columns, floors, and roofs are of noncombustible materials for which ratings are listed in AFM 88-15, but which do not qualify as fire-resistive.

20.3 **Unprotected noncombustible construction.** Construction in which structural elements are of noncombustible materials without specific fire-resistive ratings.

30. **Permanency of construction.** The design and construction of a facility is classified according to permanency as follows:

30.1 **Permanent.** This type of construction is used when it is reasonably certain that in a short time the structure will not become obsolete. It would also be used in the expansion of existing permanent facilities or in the business district of a large city. A 25-year life is considered to be permanent.

30.2 **Fifteen-year life.** Buildings in this category are designed for a reasonably trouble-free life of 15 years. Most of the buildings on a permanent site fall into this class. Buildings that can be expected to become obsolete after approximately 15 years should be placed in this category.

30.3 **Five-year life.** Buildings in this category are usually constructed during times of emergency. Temporary wartime office buildings fall into this category. The most inexpensive materials that comply with structural, sanitary, and fire protection requirements are usually employed. Prefabricated buildings and building components exemplify this type of construction.

40. **Fire protection.** If a fire extinguisher system is required by local or national codes, it should be of a type that will not damage electronic equipment. Damage to electronic equipment from water can be extensive.

50. **Layout and space requirements.**

50.1 **Equipment layout.** Maximum use will be made of all equipment rooms and areas, but sufficient aisle space and clearance should be left between equipment for servicing and repair. Equipment room layouts must provide administrative space for at least a desk, a chair, and a five-drawer file cabinet. Aisle space must not be less than any of the following:

a. Three feet.

b. Width of equipment cabinet doors plus opening clearance.

c. Width of mobile test equipment plus 6 in.

50.2 **Maintenance requirements.** If maintenance of electronic equipment is to be done on site, sufficient space must be allocated. Physical separation of the maintenance area from the on-line equipment is desirable from both an operational and an electromagnetic isolation viewpoint.

50.3 **Headroom.** Clearance from light fixtures, overhead equipment, and cable trays must be provided for safe passage of personnel. Suspended ceiling construction should allow enough room for future use of raised flooring.

60. **Environmental requirements.**

60.1 **Lighting.**

a. Equipment areas. Illumination in main equipment areas shall be a minimum of 50 footcandles (538 lux) at an elevation of 30 in. (76 cm) above the floor.

b. Maintenance area. Illumination in maintenance areas shall be a minimum of 50 footcandles (538 lux) at 30 in. (76 cm) above the floor with provisions for auxiliary lighting at the workbenches to increase the lighting to 100 footcandles (1076 lux).

c. Spacing. The maximum spacing between overhead lighting fixtures should be 0.8 of the height from the floor level to the level of the lighting fixtures. Where aisle lighting is employed, exceptions may be made to this spacing criteria.

d. External areas. Outside lighting should be installed to conform with security or other requirements for lighting during hours of darkness.

60.2 **Heating.** An ambient temperature of 68° F (20° C) should be maintained in manned facilities. Heat gain from electronic equipment should be considered when selecting the central heating unit to be installed. The unit selected must have sufficient output to maintain a temperature of 65° F (18.3° C) when all equipment is turned off. The availability and price of fuel or electricity should be examined during the selection process.

60.3 **Air-conditioning and ventilation.** Sufficient ventilation and air-conditioning should be installed to keep equipment within its operating specifications and to permit a personnel comfort level conducive to efficient operation. See AFM 88-15 for identification of those areas in the Continental United States (CONUS) that should use air-conditioned site facilities. If air-conditioning is not to be installed, ventilation provided should limit the temperature rise to no more than 10° F (5.5° C) above the exterior ambient temperature.

60.4 **Toilet facilities.** If existing toilet facilities are not available in the same or adjacent buildings, such facilities shall be provided in the new building. Plumbing fixtures shall be provided in accordance with the number of operating personnel assigned to one shift and shall be located in proximity to the electronic equipment area. If women are to be included in the facility's personnel staffing, separate toilet facilities should be provided. Unless otherwise governed by local or national codes, the ratios of fixtures shown in table B-I should be used. These ratios are based on requirements established in DoD 4270.1-M.

70. **Structural requirements.**

70.1 **Floor loading.** Unless otherwise specified in the survey directive, the following live loadings in pounds per square foot (psf) or kilograms per square meter (kg/m^2) will be used for designing new facilities or evaluating existing ones:

a. Electronic equipment areas — 250 psf (1220 kg/m^2)

b. Console areas — 100 psf (488 kg/m^2)

c. Power generation rooms — 200 psf (976 kg/m^2)

d. Corridors and other areas — 100 psf (488 kg/m^2)

e. Exceptions can be taken to these live-load requirements for existing structures, if actual equipment weight and tentative equipment layout are known, and analysis of the structure reveals that the load to be imposed will be within the working stresses of the materials involved. For purposes of analysis, a minimum personnel load of 40 psf (195 kg/m^2) should be added to the equipment load.

TABLE B-I. Toilet facility requirements.

Number of personnel	Minimum number of water closets (toilets) *	Recommended number of lavatories (sinks) **
1 — 15	1	1
16 — 35	2	2
36 — 55	3	3
56 — 60	4	3
61 — 80	4	4
81 — 90	5	4
91 — 110	5	4
111 — 125	6	5
126 — 150	6	***
Over 150	****	

* Where toilet facilities will not be used by women, urinals may be provided instead of water closets, except that the number of water closets shall not be reduced to less than two-thirds of the minimum in the table. For example, if three urinals are installed when the minimum number of water closets specified is six, water closets can only be reduced to four.

** The recommended numbers of lavatories shown correspond to the requirements for general use facilities set forth in DoD 4270.1-M. If the site can be classified as an industrial area, the requirement for lavatories is reduced to one lavatory for every three water closets (or fraction thereof).

*** One lavatory for each 45 additional personnel (or fraction thereof) over 125.

**** One water closet (or urinal) for each 40 additional personnel (or fraction thereof) over 150.

70.2 **Floor types.** If electronic equipment has been designed for power and signal cables to enter through the bottoms of the cabinets, the floors will be designed accordingly. For simple wiring layouts, cellular type self-supported floors or cable trenches in slab-on-grade floors can provide cable raceways. However, in most applications, underfloor raceway systems and raised floor systems (infinite access) are preferable to cellular floors or cable trenches. If complicated underfloor cabling and underfloor air supply ducts are required, a raised floor should be installed over the structural floor. The floor panels should be removable and supported by steel framework and steel pedestals. Equipment and power generation rooms should be constructed of either a concrete slab on grade or a reinforced slab. Steel floor decks should be covered with a concrete wearing course. Equipment room floors should be covered with resilient floor tiles. Power generation rooms do not require floor covering, but should be treated with a floor hardener.

80. **Acoustical requirements.**

80.1 **Acoustical treatment.** Electronic equipment areas should incorporate an acoustical treatment capable of keeping the ambient noise level below 65 dB. Acoustical treatment will not normally be required in dedicated power supply rooms or auxiliary power plant facilities.

80.2 **Acoustical materials.** Acoustical tile for ceilings and walls should be noncombustible and, if a bonding adhesive is used, the bonding agent itself must not constitute a hazard (fire and toxic gas emission) to operating personnel. In fire hazard areas, acoustical tile ceilings should be installed on either a metal suspension system or metal furring. In areas not classified as fire-safe enclosures, acoustical tile may be mounted on wood furring strips. For wall applications, acoustical tiles are normally installed on the upper wall surface from the ceiling to a point 6 ft (1.8 m) below.

90. **Supporting structure requirements.** Security perimeter fencing should have separate personnel and vehicle entrance gates, and there should be at least 30 ft (9 m) of separation between fencing and buildings. If the site is remote from other available vehicle parking areas, space for parking shall be provided. The number of parking spaces shall accommodate one complete operational shift and at least two visitors. As a minimum, there shall be at least five parking spaces. If space is available, the parking area should be capable of 100 percent overfill to facilitate shift change and other periods of high use.

APPENDIX C. POWER DISTRIBUTION AND LOAD REQUIREMENTS

10. **Power distribution.**

10.1 **General.**

a. The electrical distribution systems for telecommunications facilities shall be designed to conform to the standards set forth in the National Electrical Code (NEC), as modified by this handbook and other appropriate documentation of the respective service or host country. Due to the low signal voltage levels imposed by solid state technology, modern communications equipment has become increasingly sensitive to induced electrical noise. Facility signal and power distribution systems must be designed and installed to minimize the coupling of unwanted noise from power conductors.

b. For ac primary power, the frequency and voltage available within the host country or at the host installation will normally be used. The frequencies and voltages generally available in various countries are tabulated in FM 11-486-7/TO 31Z-10-22. Electric generating plants will operate at the line frequency available in the host country. Most U.S. communications equipment is designed for 60-Hz operation but is usable with 50-Hz power. When equipment that can function only at 60 Hz must be used and 60-Hz power is unavailable, frequency converters must be employed. The need for frequency converters should be recognized at the start of a project and included in the planning documentation.

c. Whether a 3- or 5-wire distribution system is used, the loads are connected between a power-carrying (phase) conductor or conductors and the neutral wire. Fuses or circuit breakers are always wired in the phase conductor(s). In a multiphase system, a load connected between two or more phases is evenly distributed among the phases. However, single-phase loads affect only the phase to which they are connected. Any unbalanced load condition between phases results in a flow of current through the neutral wire. If the ac neutral is grounded at more than one place, or if the ac neutral (white) and fault-protective (green) wires are reversed, undesired neutral current will flow in the ground system. Therefore, white and green distinctions should be observed, and loads should be balanced among phases to minimize ac currents in ground circuits.

d. If the technical load of a building or facility is supplied from two separate primary ac power sources that are not in phase, the two distribution systems must be treated as distinct systems. This requires separate ac neutral and fault-protective ground conductors, one for each primary power source. Each system will use the facility's common earth electrode subsystem, but there should be no other direct connection between the two power systems. An example of such a dual supply is the normal commercial power supply and motor-driven no-break power system.

e. Dc power sources will normally be of the static, floating-battery type. Primary dc power sources usually consist of two or more rectifier-chargers, a battery bank, converters, and inverters (if required). Rectifier-chargers are devices that change primary ac power to dc for use in supplying the dc load and for maintaining (floating) the battery bank at its proper charge level. Converters are used to change the primary dc power to other dc voltage levels. Inverters change the primary dc power to ac for use by the ac critical load. A typical 48-V battery bank consists of 24 cells in series or, if the ampere-hour requirement is large, several series in parallel. The battery bank will normally operate in a floating condition at 52.3 to 53.0 Vdc and is capable of sustaining power during short periods of primary ac power outage.

f. Dc power distribution systems are designed by the base or post engineers in accordance with the NEC. Most dc distribution systems operate at 50 V or less and are 2-wire, ungrounded systems. Where 3-wire systems are used, the NEC specifies that the neutral conductor must be grounded.

20. **Ac power.**

20.1 **Wiring.** The wiring for ac distribution systems within telecommunications facilities must conform to standards set forth in the NEC as modified by current Government or host-country codes or standards.

20.2 **Conduit and duct work.** Ac power distribution systems make use of conduit, wireways, ducts, busways, cellular flooring, raised flooring, and cable racks to provide conductor runs between power panels and their loads. Requirements for RED/BLACK power distribution are specified in NACSIM 5203. Design and installation practices for fulfilling the NACSIM requirements are contained in MIL-HDBK-232. The enclosing of conductors within metal conduit or duct work is required when electromagnetic interference exists or is a potential problem.

20.3 **Power panels.** Power panels contain switches, buses, and protective devices for connecting and disconnecting the outside power source. Power panels are enclosed in cabinets or cutout boxes placed in or against a wall or partition and are accessible from the front. Large installations have a service entrance panel to which the outside power source conductors are connected. Power is routed from the entrance panel to the equipment through distribution panels that provide service and protection to individual loads.

20.4 **Grounding.** The NEC specifies that if a fault-protective conductor is available, it and the ac neutral should be grounded at only one point at each site. This grounding should take place at the facility main service disconnect panel or at the main site transformer. If a fault-protective conductor is not available between the site buildings and the ac power source, and one cannot be economically installed, the ac neutral must be grounded at one point only at each building (i.e., at the service disconnect panel for each building). Electrical supporting structures such as conduit, cable trays, raceways, wiring enclosures, and metallic power cable sheaths should be continuously bonded to the fault-protective circuit. Ungrounded ac supporting structures could generate unwanted low-frequency electrical noise in sensitive equipment.

20.5 **Engine-driven ac generators.** When commercial power is unavailable or unreliable, on-site engine generators are used as primary and auxiliary sources. Data on generators can be found in FM 11-486-7/TO 31Z-10-22 and in MIL-STD-633.

30. **Dc power generation and distribution.** Dc power has a number of applications in telecommunications. 48-Vdc power has been used by the telephone industry since near the turn of the century. Higher dc voltages are used in uninterruptible and no-break power systems (see 50.). Dc power is normally derived from batteries or from rectification of ac power. The load voltage of a dc power facility can be controlled by counter electromotive force (cemf) diodes (figure C-1), or by the addition or deletion of 'end-cells' to the main battery bank (figure C-2). Dc power facilities can also be designed without load voltage control. For safety reasons, dc power facilities are normally located within a separate room (figure C-3) or at least within a separate area of a larger room. This room or area must be well-ventilated and must meet the safety requirements set forth in the telecommunications section of OSHA 1910. Because dc power systems can be a serious source of rf noise, filters must be installed in the dc distribution system (figure C-4) to prevent noise from reaching communications equipment or the signal reference subsystem of the facility. Dc distribution systems usually carry much higher currents than ac systems; consequently, these filters, as well as such items as fuse panels and conductor loops, must be considered in load calculations.

40. **Voltage transient suppressors.** Voltage transient suppressors are devices that prevent surges of electromagnetic energy from reaching electronic equipment. These surges can result either from electrical storms along power transmission lines, or from the switching of large reactive loads. The suppressors are installed at locations in the power distribution system where they can effectively shunt potentially damaging voltage surges before they harm sensitive components. In effect, the suppressors 'clamp' surges to a value no higher than a predetermined level. The more common types of voltage transient suppressors are discussed below.

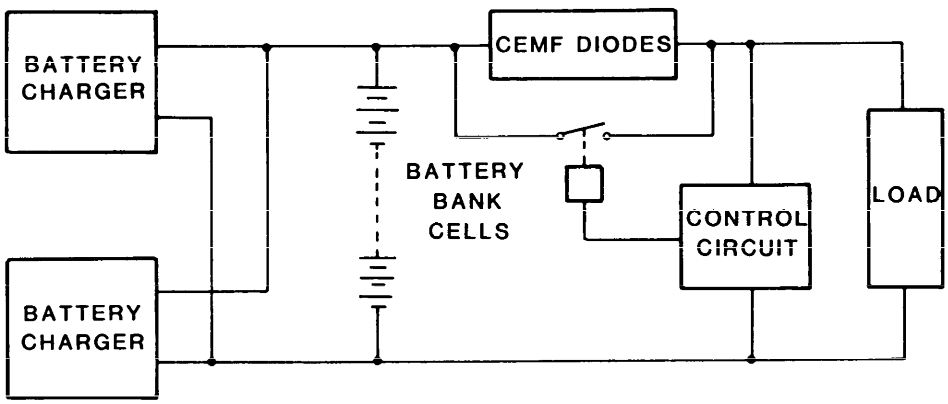


FIGURE C-1. Typical cemf-diode battery facility.

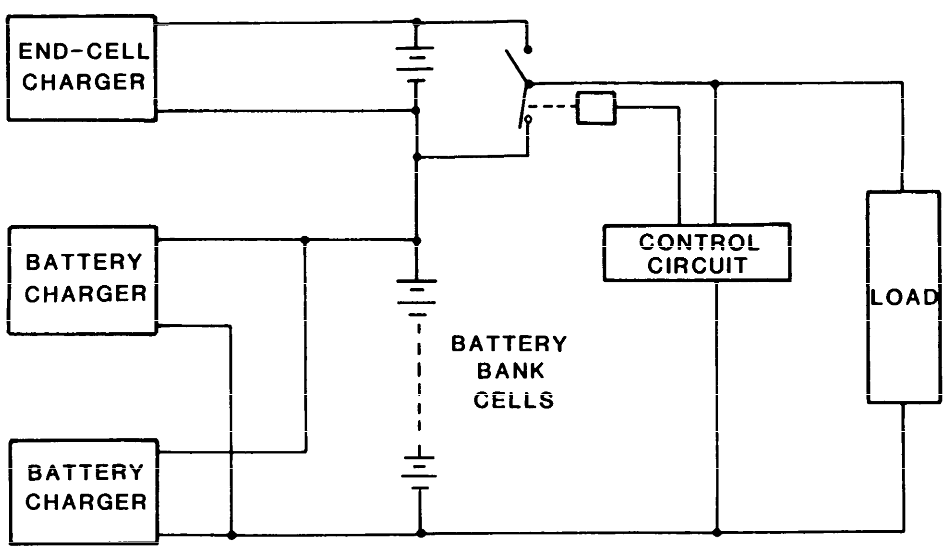
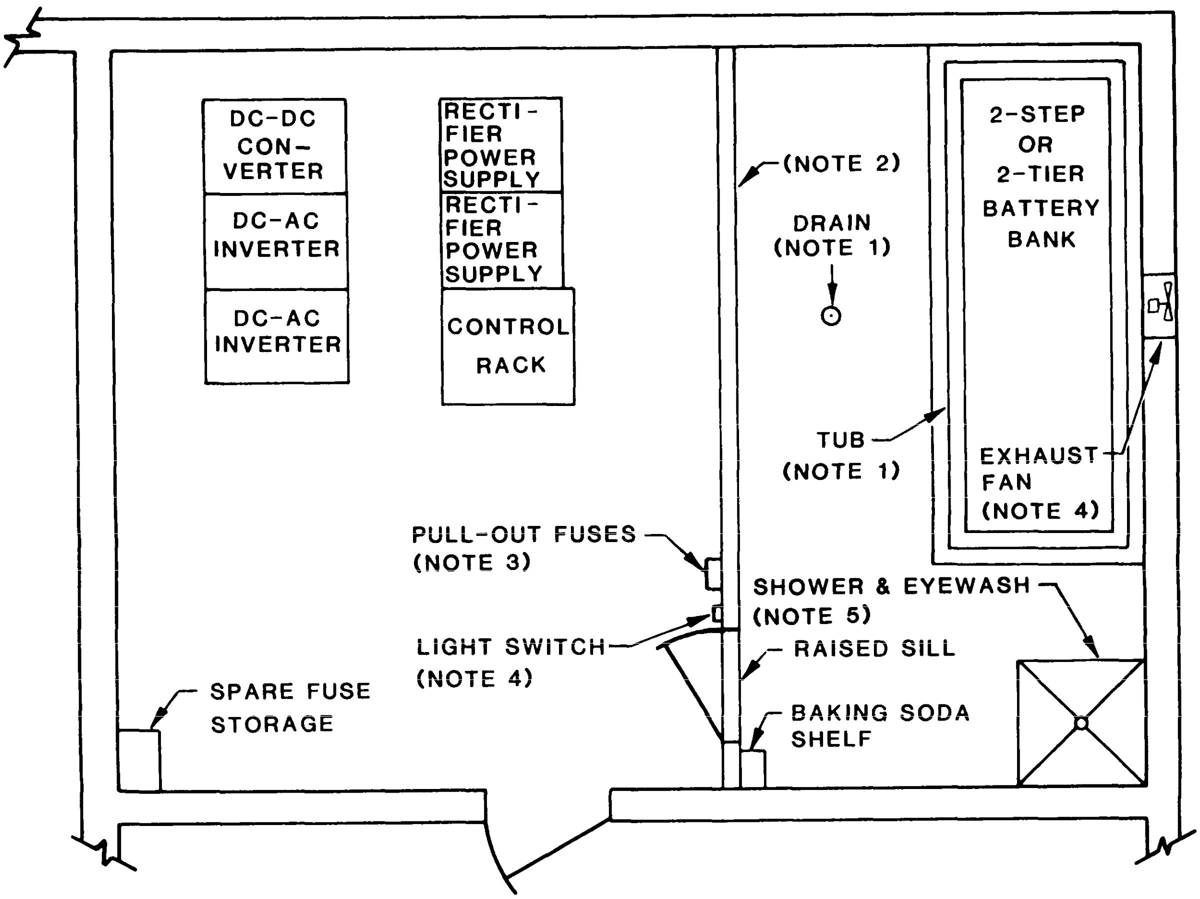


FIGURE C-2. Typical end-cell battery facility.



NOTES:

1. TUB REQUIRED WHEN FLOOR DOES NOT SLOPE TO CENTRAL DRAIN.
2. PARTITION CAN BE OMITTED IF EQUIPMENT AND BATTERY BANK ARE IN LARGE, WELL-VENTILATED AREA AND EQUIPMENT IS SPARKPROOF.
3. FUSES MOUNTED NEAR DOOR WHEN CONTROL RACK IS OVER 30 FEET (7.6m) FROM BATTERY TERMINALS.
4. EXHAUST FAN AND BATTERY ROOM LIGHTS MUST BE SPARKPROOF.
5. SHOWER AND EYEWASH CAN BE OMITTED IF WATER BOTTLE IS PROVIDED IN BATTERY ROOM.

FIGURE C-3. Typical dc power room.

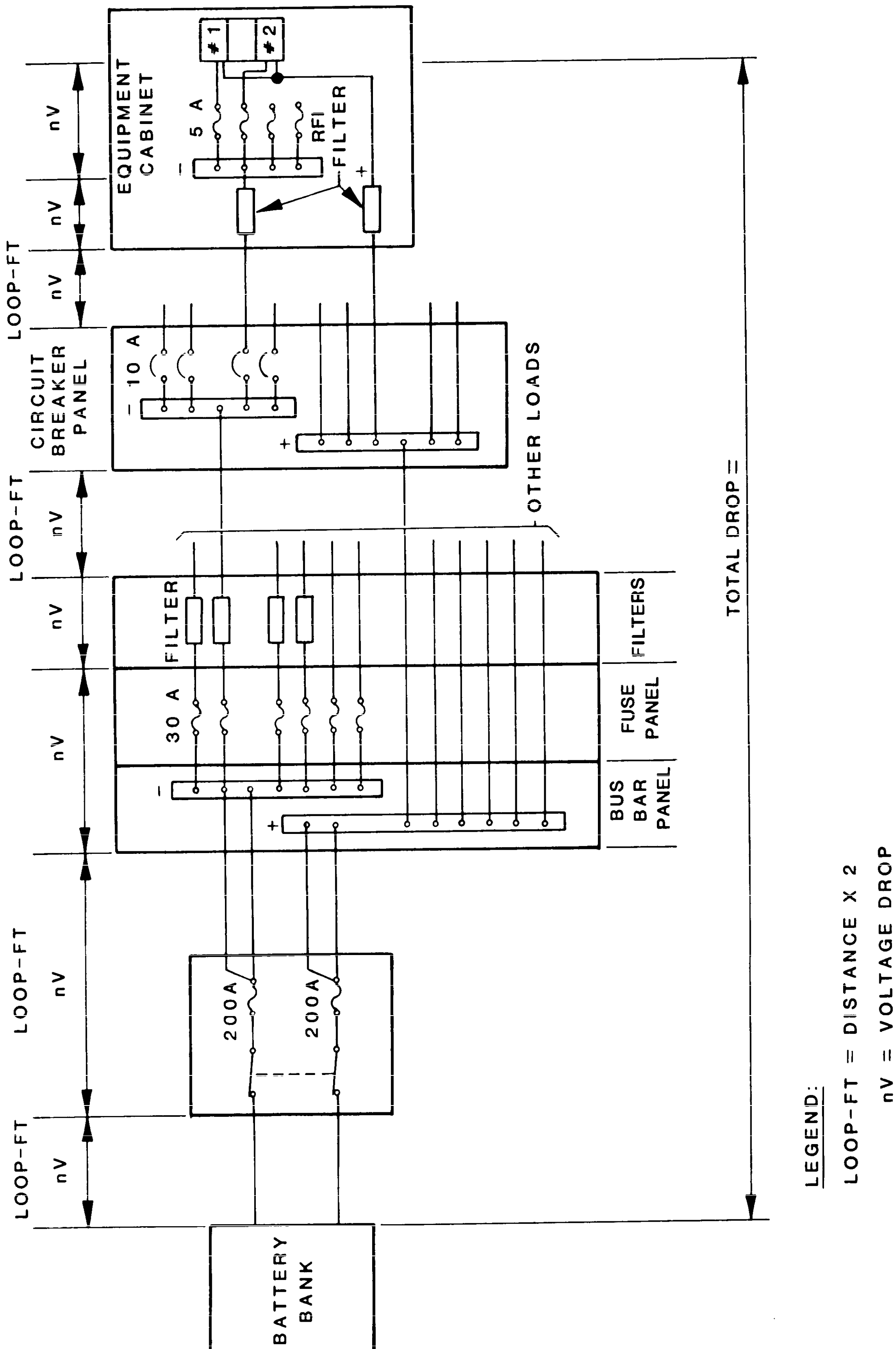


FIGURE C-4. Typical dc power distribution system.

a. Gas tubes. A gas tube consists of a pair of electrodes contained in a gaseous atmosphere, and a shunt connected to the line being protected. When the line voltage exceeds a certain peak value (caused by a voltage surge), the gas between the electrodes ionizes, forming a conductive path (short circuit) that dissipates the surge.

b. Varistors. Varistors, notably metal-oxide varistors (MOVs), are devices that have very high resistance below a certain peak voltage. As voltage increases above this peak, the resistance drops rapidly toward that of a short, thus shunting surge currents away from sensitive equipment.

c. Zener diodes. Zener diodes operate in a manner very similar to varistors. Above a certain voltage the device can be used to shunt surge currents. The major difference between zeners and varistors is that the zener is a unipolar device and therefore must be used in series back-to-back to clamp both positive and negative voltage surges.

d. Selenium rectifiers. Selenium rectifiers are metal-oxide diodes with reverse-voltage breakdown characteristics very similar to those of zener diodes. Selenium rectifiers are not recommended for general use; in most cases where they could be used, zener diodes are preferred.

40.1 **Comparison of suppressors.** Of the suppressors listed, gas tubes are capable of dissipating the highest level of energy surges, but have the slowest response time. Zeners have fast response times but relatively low peak-current ratings. MOVs have medium to fast responses and peak-energy ratings between those of zeners and gas tubes. MOVs have a tendency to short-circuit when they fail, and therefore should always be used in conjunction with circuit breakers and slow-blow fuses. Selenium rectifiers, due to the danger of toxic fumes produced when they fail, are no longer recommended for general use in inhabited areas.

40.2 **Installation of voltage transient suppressors.** The preferred method is to install suppressors across the power lines (phase-to-phase or phase-to-neutral). If connected between a power line and the safety ground, the resulting transient currents can produce electrical noise in sensitive equipment. Since no single suppressor can completely protect electronic equipment from transient voltages, different types should be used in tandem. For example, use gas tubes at the facility's power entry point because of their high-energy dissipation capabilities, but also install MOVs at individual equipment or distribution panels to absorb energy that gas tubes let pass due to their slower response time. Additional information on transients and transient protection can be found in MIL-HDBK-419.

50. **No-break and uninterruptible power supplies.** Uninterruptible ac power can be supplied by one of two categories of power supplies, or a combination of both. One category is made up of systems that store kinetic energy for use during primary power outages or deviations from normal voltage and frequency characteristics. Power supplies in this category are referred to as no-break power supplies. The other category consists of systems that store potential or chemical energy, such as fuel cells or batteries. Power supplies in this category are referred to as uninterruptible power supplies (UPSs). Additional information on uninterruptible and no-break power supplies can be found in ANSI/IEEE Std 446.

50.1 **Mechanical stored-energy systems (no-break power supplies).**

a. No-break power supplies deliver continuous power by converting kinetic energy 'stored' in a rotating flywheel (see figure C-5). During a power outage, the flywheel inertia momentarily powers the critical load until the auxiliary diesel power is engaged. Such a power supply can accommodate power outages of long duration. This arrangement is also quite effective in conditioning the critical load power by smoothing minor variations of voltage and frequency in the input ac power.

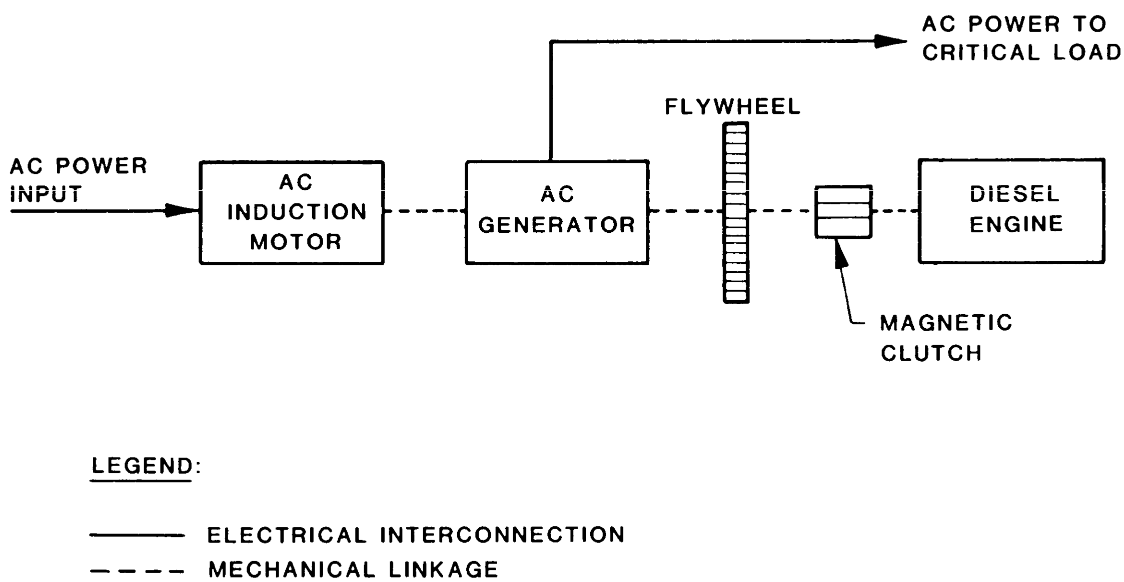


FIGURE C-5. No-break power supply using a diesel engine.

b. A variation of the no-break power supply uses batteries to store energy instead of a flywheel (see figure C-6). In this variation, the ac input is converted to dc by a rectifier. The rectifier output powers the critical load through a dc-ac motor-generator arrangement and also float charges a battery bank. During a power outage, the floating batteries continue to power the ac generator, which in turn powers the critical load. The length of outage that can be sustained is determined by the battery bank capacity. Sufficient capacity should be installed to maintain the critical load until a standby ac power source can be brought on-line.

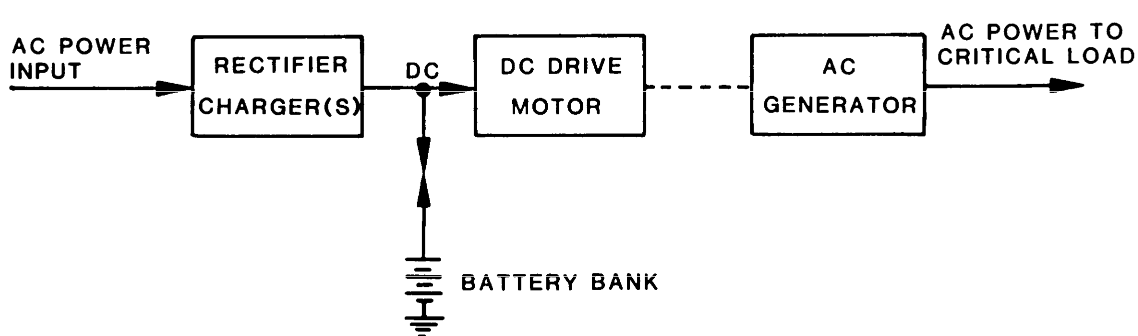


FIGURE C-6. No-break power supply using batteries.

50.2 **Uninterruptible power supplies.** Uninterruptible power supplies (UPSs) differ from no-break power supplies by having no moving parts (see FM 11-486-7/TO 31Z-10-22). For this reason, they are sometimes referred to as static systems. Since the length of time that an uninterruptible power supply can sustain the critical load is determined by battery capacity, the system should have sufficient capacity to allow a standby engine-generator to be brought on-line. An uninterruptible power supply with a standby source is shown in figure C-7. UPSs should be considered when power requirements for the critical load are relatively small (less than 10 kVA).

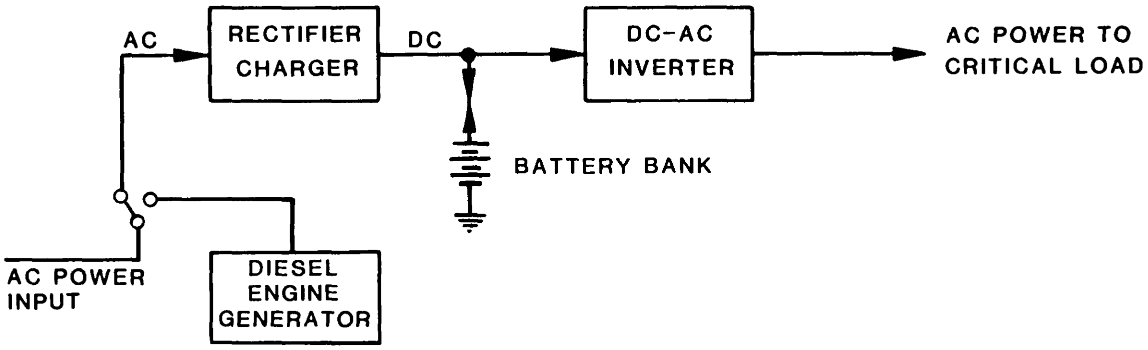


FIGURE C-7. Uninterruptible power supply with standby source.

60. **Power requirements.** This handbook is concerned with the surveys of telecommunications station electrical power systems from the facility main service disconnect panel to equipment power inputs. Criteria for commercial or off-site military electrical power equipment (generators and transmission systems) are beyond the scope of this handbook except for electrical characteristics (voltage, current, and phases) and surge protection affecting the quality of power delivered. General characteristics of on-site generation equipment are discussed.

60.1 **Power source classification.** Table C-I, reproduced from FM 11-486-7/TO 31Z-10-22, defines classes of electrical power.

60.2 **Electrical load type.**

60.2.1 **Nontechnical load.** Lighting, ventilation, and air-conditioning not needed for full communications operations.

60.2.2 **Technical load.** Communications equipment and lighting, ventilation, and air-conditioning equipment needed for full communications operations.

a. Noncritical technical electronic load. All communications equipment not approved for supply from an UPS or no-break power supply.

b. Critical technical electronic load. Equipment such as automatic switching equipment, Defense Communications System (DCS) equipment, or tactical equipment, requiring continuous synchronous operation, and hence must be connected to an UPS or no-break power supply.

c. Noncritical technical utility load. All noncommunications equipment, such as electric typewriters and office machines.

TABLE C-I. Classes of electric power.

POWER CLASS	OPERATIONAL POWER REQUIREMENT	CHARACTERISTICS
Primary power, class A	Includes all utility and critical technical operational loads resulting in a steady-state operational requirement.	Steady-state power, subject to various voltage and frequency deviations, transients, and occasional complete power failure.
Auxiliary power, class B	Same as class A; capable of indefinite operation; should have 15-days fuel supply available. Auto system operational at ± 10% voltage after 5-second delay. Covers extended outages that may last for days.	Supplement to primary power. Subject to complete loss of synchronized power for approximately 20 seconds during automatic power transfer after primary power loss.
Auxiliary power, class C	Provides auto-start power plant to provide rapid restoration of power to the technical load. Starts on voltage variation of ± 10% or on frequency variation of ± 3.3% with an adjustable time delay of approximately 5 seconds. Minimum fuel supply of 7 days. Covers outages of relatively short periods (hours).	Supplement to primary power. Assumes load in the shorted practicable time after failure of primary power (10 to 60 seconds).
Uninterruptible power system and no-break power, class D	Provides continuous uninterruptible power and prevents the occurrence of transients and surges on the critical technical load.	Automatically assumes load when required and automatically shifts load back when primary power becomes available. No power interruption and minimum voltage and frequency deviations.

60.3 **Determining the load at a telecommunications facility.** The primary responsibility for determining power loads rests with the communications-electronics engineer. He also must determine the precise characteristics of the load in terms of basic voltages and frequencies, and the allowable voltage and frequency tolerances. The electrical loads to be supplied — their demand, voltage, phase, and frequency requirements — all govern the selection of the primary source and auxiliary generating equipment.

60.4 **Load estimating.**

a. Load data use for planning communications facilities must include estimates of the projected load for a period of at least five years. The master planning goal of 20 years should also be considered. Projections of loads should include requirements for both technical and nontechnical communications loads, as well as utility loads.

b. On-site power surveys are the best basis for making sound load projections. Therefore, the presurvey team should research available files to determine if any recent power surveys have been made of the site in question. In the absence of such file records, load data may be developed from the manufacturer's technical description of the equipment and an up-to-date list of current or planned equipment and utilities. Appendix F, annex A, provides worksheets that may be used in recording load data.

c. Equipment may have either a cyclic or constant demand for power. To calculate a facility load, cyclic loads are converted to an average equivalent load. (See FM 11-486-7/TO 31Z-10-22.) By combining this average with the sum of noncyclic loads, the total load can be estimated.

d. During the conduct of a site survey, agreement should be reached as to power sources and facilities that are to be provided by the local command.

60.5 **Power factor.** Inductive and capacitive loads cause differences in phase between voltage and current in ac circuits. When such a phase difference exists, the power consumed by the load (true power measured in watts) is less than the apparent power that must be provided by the source (apparent power measured in volt-amperes). Consequently, a partially reactive load consuming a specific power input in watts will demand a greater volt-ampere input than a nonreactive load. The ratio of real to apparent power is called the power factor (PF), and it can be calculated as the cosine of the phase angle difference between voltage and current. A PF of 1.00 is the most efficient power factor (least demand on the power source) and means the load is nonreactive. Telecommunications facilities contain many transformers and ac motors and tend to be inductive (PF < 1.00). The DoD Construction Criteria Manual 4270.1-M requires that all equipment installed in a facility have a PF of not less than 0.9. The power factor for the total facility load, however, is normally lower than that of the individual pieces of equipment. If the power factor for the total facility drops below 0.8, capacitance should be added across the ac power source. This reduces the apparent power (kVA) demand on the source. It is usually not cost effective to improve PFs already greater than 0.95.

60.6 **Load balancing.** In a facility fed by a multiphase power source, single-phase loads should be connected evenly among the available phases. Unbalanced loading results in current on the neutral conductor, which can cause noise in the signal reference ground subsystem. Voltage regulation also becomes difficult with unbalanced loading. Higher-than-normal voltages will occur on lightly loaded phases while lower-than-normal voltages will occur on heavily loaded phases. In normal operation of a telecommunications facility, single-phase loads are periodically switched on and off. Nevertheless, the load balance should be maintained within 10 percent. Equipment with a large cyclic demand (e.g., air-conditioners) should only be of the three-phase variety.

60.7 **Load startup (peak) requirements.** Certain equipment that periodically switches on and off can cause severe load variations. These variations result in current surges and voltage sags on the ac power supply lines. For example, the current variations caused by the cycling of an air-conditioner compressor produce voltage sags because of its large startup current requirement. One method of correcting this problem would be to provide the air-conditioner with a separate transformer feed from the ac mains. Another method, used when only a single ac feed is possible, employs special continuous-running compressors in the air-conditioners. This minimizes current variations.

APPENDIX D. TROPOSPHERIC MICROWAVE RECEIVED SIGNAL LEVEL CALCULATION

10. **Received signal level.** Whether or not a given location is suitable for use as a site for a tropospheric scatter station depends on the received signal level of transmissions to and from the site. If the received signal level for a link falls below a minimum determined by the project engineer, better equipment must be used or a better location for the site must be found. Checking the suitability of new locations will usually be the responsibility of the survey team. To do this, the team must know: (1) the minimum received signal level required by the project engineer, (2) characteristics of the sites and communications equipment at both ends of each link, and (3) how to calculate the actual received signal level for the proposed links. This appendix explains how to calculate received signal levels, given certain information about proposed sites and communications equipment. The received signal level for a link is the difference between the total path gains and total propagation losses (see figure D-1). Paragraph 20. below shows how to determine the total path gain; paragraph 30. shows how to determine total propagation losses.

20. **Total path gain.** The total path gain is the sum of the transmitter output power, the antenna gains at both ends of the circuit, minus feed line losses at both ends of the circuit. To determine the total path gain:

a. Convert the transmitter output power to decibels referenced to one milliwatt (dBm) using the following equation:

Output power (dBm) = 30 + 10 log output power in watts

EXAMPLE — A transmitter output power of 1 kW gives:

$$30 + 10 \log 1000 = 30 + 30 = 60 \text{ dBm}$$

b. Use figure D-2 to estimate the antenna gain.

EXAMPLE — At an operating frequency range of 4.4 - 5.0 GHz, an antenna reflector diameter of 16.4 ft (5 m) gives a minimum gain (at 4.4 GHz) of approximately 45 dB and a composite (transmit and receive) gain of 90 dB.

c. Calculate the total path gain: (1) add the transmitter output power (in dBm) to the composite (transmit and receive) antenna gain, and (2) subtract the composite transmission line losses.

EXAMPLE — Assuming a composite line loss of 1.5 dB, the total path gain is:

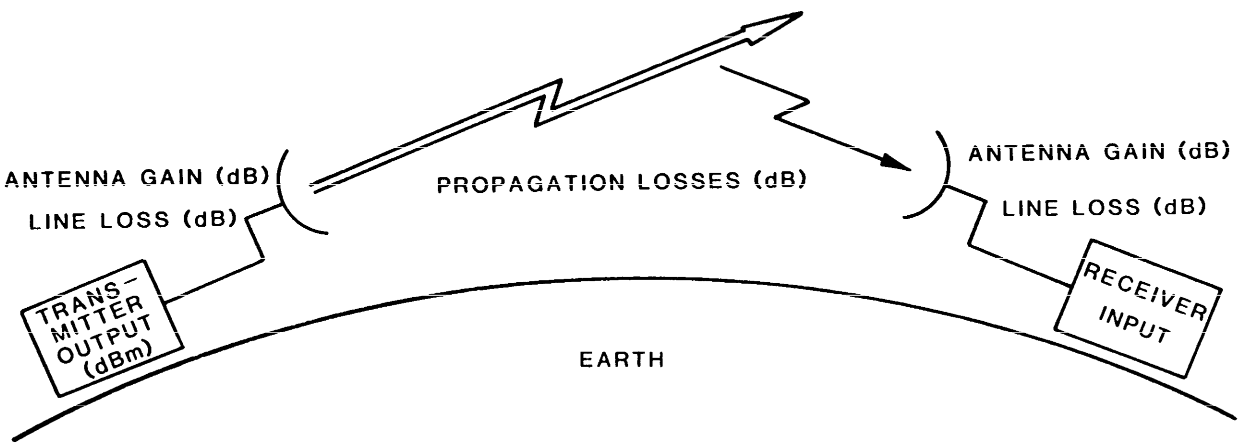
$$(60 + 90) - 1.5 = 148.5 \text{ dBm}$$

30. **Propagation losses.** The total propagation loss is the sum of the basic propagation loss, the loss due to elevated horizon angles, and the aperture-to-medium coupling loss. To calculate the total propagation loss:

a. Determine the basic propagation loss (BPL) using figures D-3 and D-4. Figure D-3 gives BPL vs. distance normalized to 1.0 GHz, and figure D-4 gives a correction factor for adjusting the BPL to the operating frequency.

EXAMPLE — For a path distance of 100 mi (160 km) at an operating frequency of 4.4 - 5.0 GHz, the BPL at 1.0 GHz is 194 dB, the worst case (5.0 GHz) frequency correction factor is 21 dB, and the total loss is:

$$194 + 21 = 215 \text{ dB}$$



RECEIVED SIGNAL LEVEL = (TOTAL PATH GAIN)-(PROPAGATION LOSSES)

WHERE: TOTAL PATH GAIN= (TRANSMITTER OUTPUT)
+(TRANSMIT ANTENNA GAIN)+(RECEIVE ANTENNA GAIN) - (LINE LOSSES)

AND

PROPAGATION LOSSES = (BASIC PROPAGATION LOSS) +(HORIZON ANGLE LOSS) + (APERTURE-TO-MEDIUM COUPLING LOSS)

dB= DECIBELS
dBm= DECIBELS REFERENCED TO ONE MILLIWATT

FIGURE D-1. Losses and gains in a tropospheric scatter circuit.

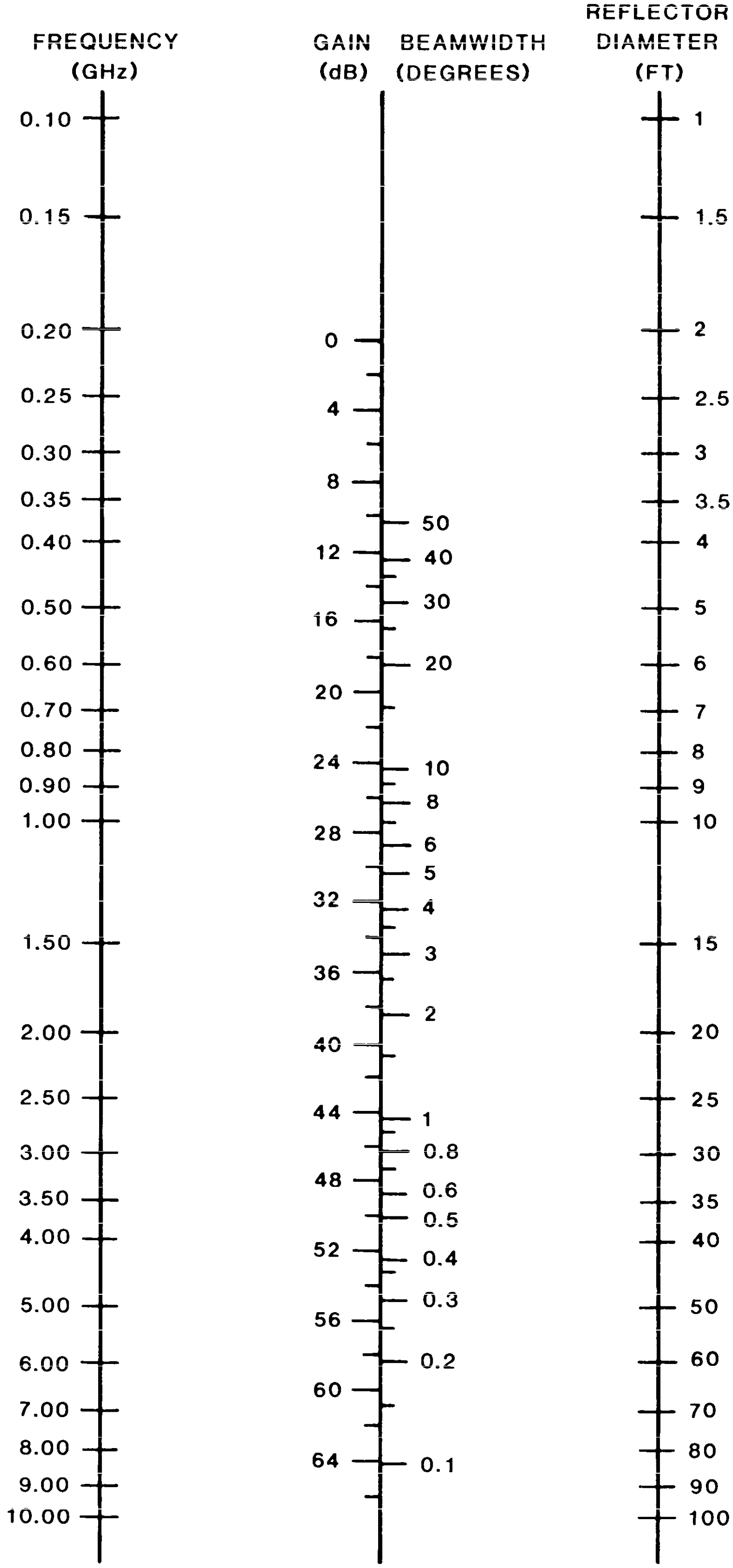


FIGURE D-2. Nomogram for determining antenna gain and beamwidth.

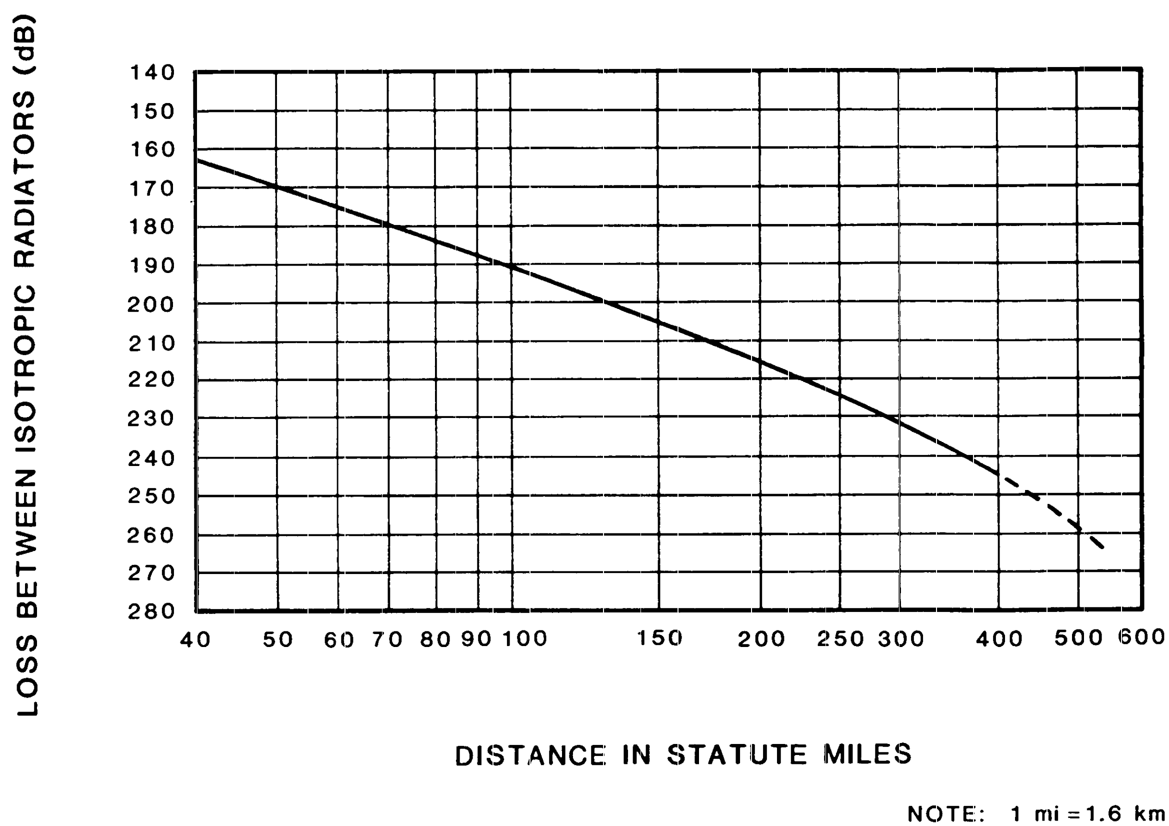


FIGURE D-3. Basic propagation loss at 1.0 GHz.

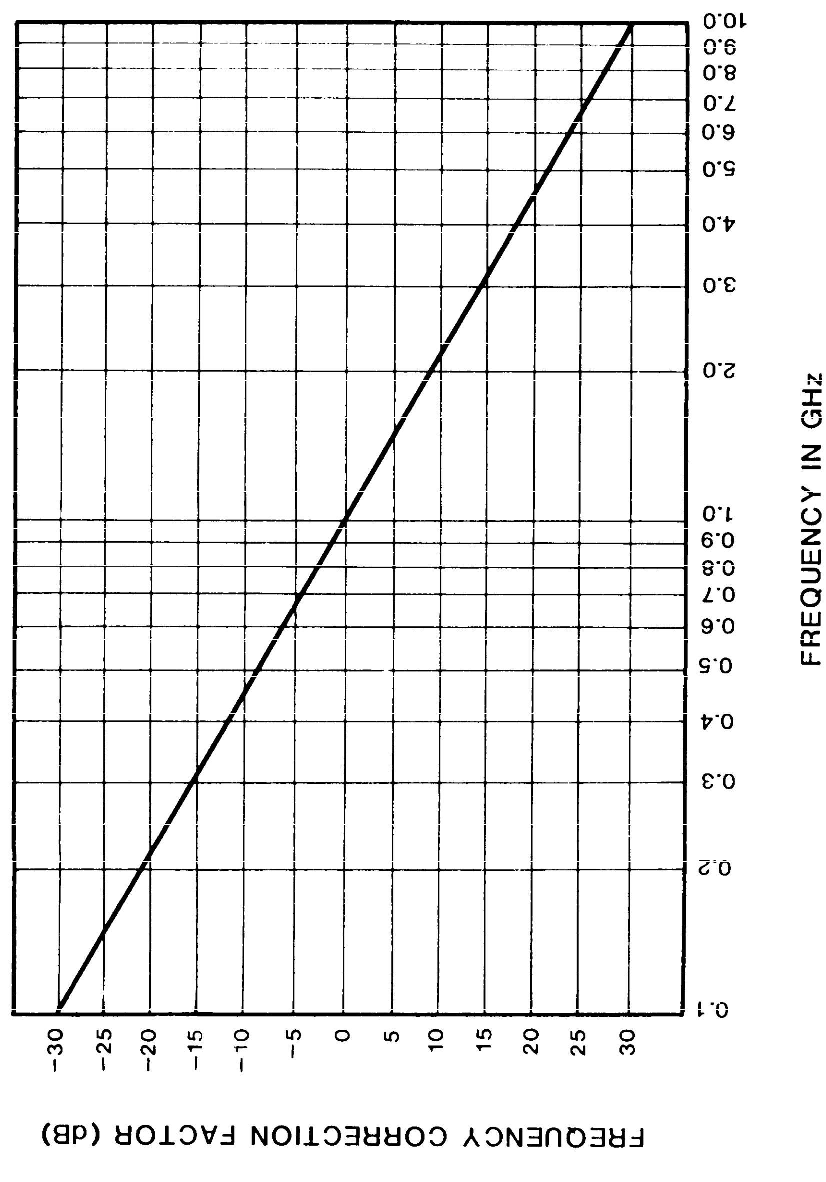


FIGURE D-4. Correction factors for basic propagation loss at frequencies other than 1.0 GHz.

b. Determine losses due to elevated horizon angles by using figure D-5. To use this figure, enter the graph on the horizontal axis using the sum of the horizon angles (both sites), then find the point at which this angle intersects the curve corresponding to the path distance and read the loss on the vertical axis.

EXAMPLE — Assuming a composite horizon angle of 0.5 degree and a path distance of 100 mi (160 km), the loss is approximately 8 dB.

c. Use figure D-6 to determine the aperture-to-medium coupling loss. To find this loss, first determine the scatter angle as follows: (1) on the nomogram, find the angle opposite the distance corresponding to the path length; (2) add to this angle the sum of the horizon angles as determined from a 4/3 earth path profile plot. Next, determine the antenna beamwidth from the nomogram in figure D-2. Antenna beamwidth is read as the straight-line intersection point between the frequency and reflector diameter.

EXAMPLE — Using the path distance and combined horizon angle of our previous example (100 mi/0.5°) and figure D-6, the scatter angle is (1.08 + 0.5) = 1.58°.

— From figure D-2, the beamwidth which corresponds to an antenna gain of 45 dB is 0.9°.

The aperture-to-medium coupling loss can then be read from figure D-6 as the straight-line intersection between the scatter angle and antenna beamwidth.

EXAMPLE — Using a scatter angle of 1.58° and an antenna beamwidth of 0.9°, the aperture-to-medium coupling loss is approximately 5 dB.

d. Calculate the total propagation loss by adding together the above individual losses. For our example, the total propagation loss is:

$$215 + 8 + 5 = 228 \text{ dB}$$

40. **Predicted median received signal level.** The difference between the total path gain and the total propagation loss gives the predicted median received signal level. In our example it would be:

$$148.5 - 228.0 = -79.5 \text{ dBm}$$

50. **Circuit feasibility.** Circuit feasibility depends on the fade margin at the receiver. The fade margin is the difference between median received signal level and the signal level required for threshold. The signal level required for threshold depends on the receiver noise figure and bandwidth. If, for example, the required signal level for threshold is −98 dBm, then the fade margin would be −98 − (−79.5) = −18.5 dB. The grade of service dictates how much fade margin is required.

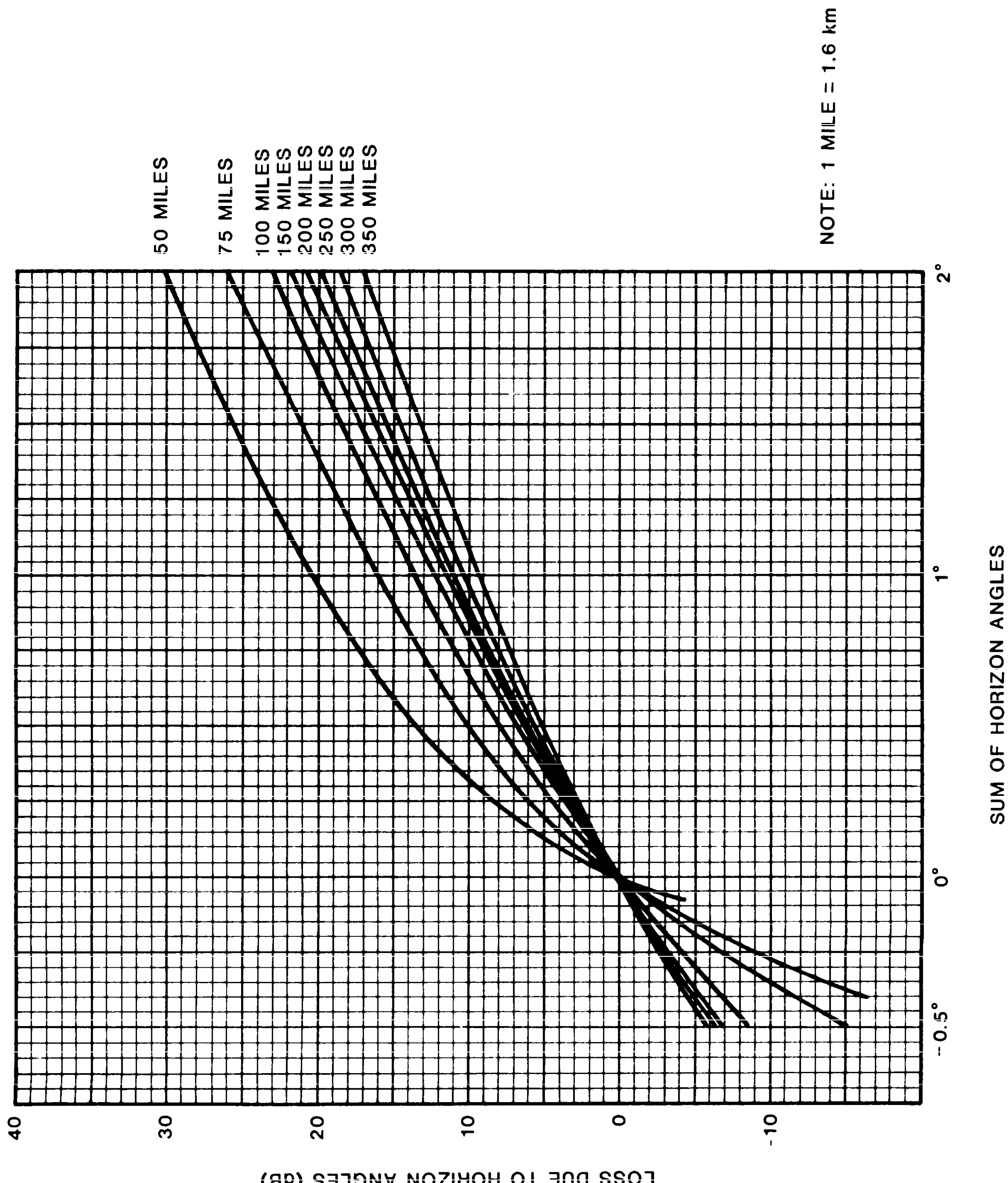


FIGURE D-5. Loss due to elevated horizon angles.

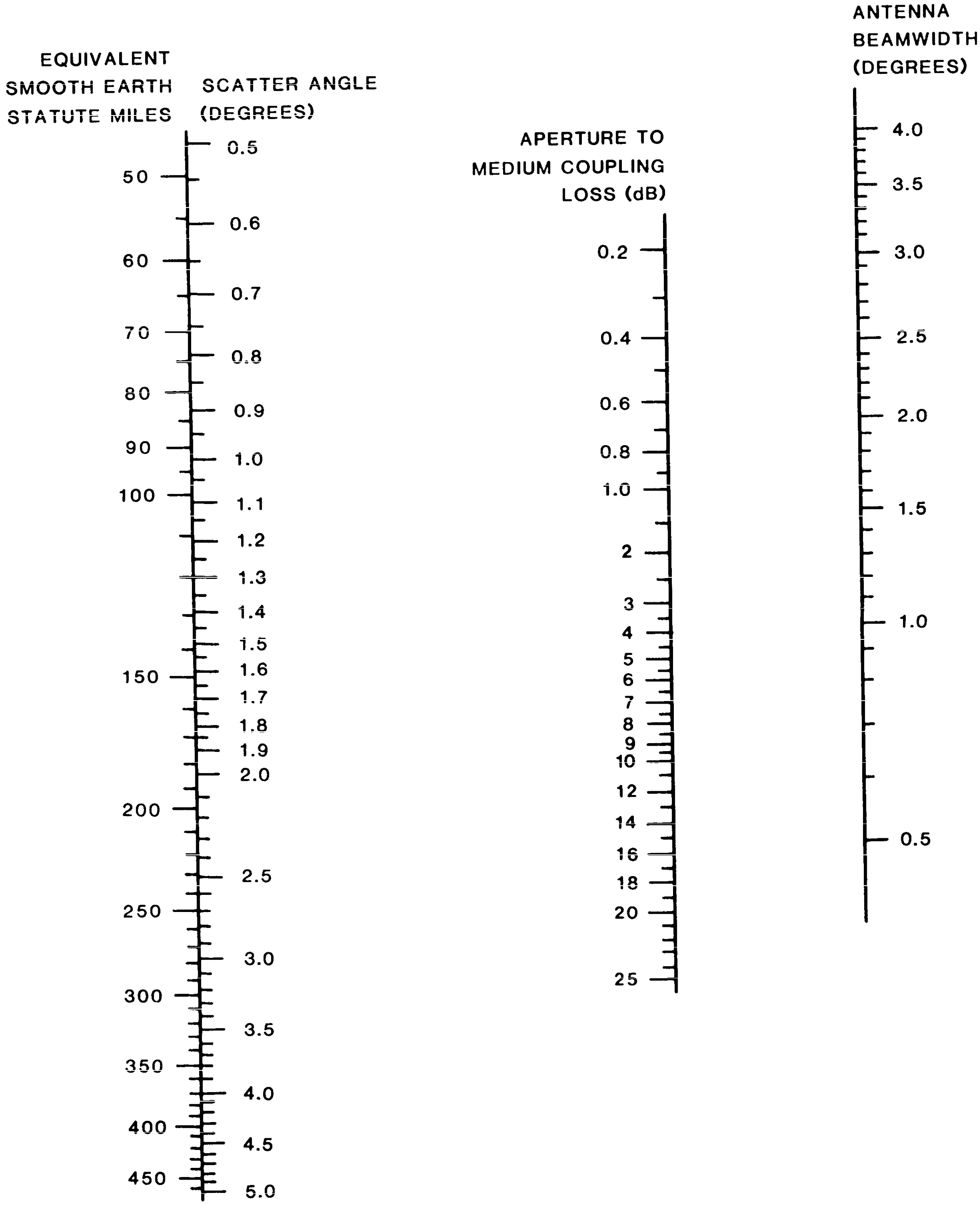


FIGURE D-6. Nomogram for determining aperture-to-medium coupling loss.

APPENDIX E. LOCAL AREA NETWORKS

10. **General.** In the past, the need for internal network switching fostered the development of the private branch exchange (PBX). Early use was limited to abbreviated dialing of locally connected voice subscribers (dial-up intercom service). In recent years, this has expanded to include most existing forms of telecommunications services such as data, video, facsimile, and remote monitoring. Such networks are now called local area networks (LANs). Essentially, a LAN is a nonpublic telecommunications network within a limited area, such as a room, a building, a campus, or a military base. LAN designs and capabilities vary extensively among manufacturers. A brief description of the major types of LANs and their requirements follows.

20. **LAN topologies.** There are three main types of LAN configurations, or 'topologies': the bus, the ring, and the star. It is also possible to create hybrid topologies by combining features of the three principal topologies. For example, several busses can be joined together to form a ring of busses.

20.1 **Bus LANs.** Bus LANs are best suited to applications involving relatively low utilization and the passing of relatively short messages, such as in office automation. In the bus topology (figure E-1a), each subscriber (node) is connected to a common communications bus. Subscribers broadcast into the bus, and thereby to all other subscribers. No host computer is required, as traffic processing is distributed among the subscriber nodes. Discrete addresses permit subscribers to ignore traffic not intended for their use. Bus topologies allow individual nodes to be out of service or to be moved to new locations without disrupting service to the remaining subscribers. The primary disadvantage of the bus topology is that subscribers must contend with each other for the use of the bus (simultaneous transmissions by more than one node are not permitted). This problem can be solved by using one of several types of systems designed to control access to the bus; 'collision detection,' 'collision avoidance,' and 'token passing.' In 'collision detection' systems, special equipment senses the 'collision' between simultaneous transmissions and causes one of the subscribers to postpone its transmission until the other subscriber is off the bus. In 'collision avoidance,' the collision never occurs; equipment senses the presence of a transmission on the bus and denies access to other subscribers until the bus is free. Collision detection systems and collision avoidance systems become less effective as distance between nodes increases; hence, bus LANs using such systems are not well suited to applications requiring relatively long cable runs. In 'token passing' systems, an encoded 'token' is passed from one subscriber to another. At any given time, only the subscriber that has the token is allowed to transmit into the bus.

20.2 **Ring LANs.** Ring LANs function better under high loads than bus LANs and are better than busses for time-critical operations. In the ring topology, as in the bus, processing is distributed among the subscriber stations; no host computer or central node is required. Subscribers pass information in one direction around a ring (figure E-1b). Each node receives all information, extracts information addressed to it, adds outgoing information addressed to other nodes, then retransmits the entire packet to the next node in line. Most ring LANs employ a token-passing protocol (see 20.1) that allows only one terminal (the one with the token) to transmit at any given time. In the simple ring topology, a failure at any one node could interrupt information flow throughout the network. This can be prevented by using a wiring closet and bypass relays.

20.3 **Star LANs.** In the star topology (figure E-1c), subscriber workstations are individually connected to a central master node. Processing can be centralized in this master node or distributed among the subscribers. In the latter case, the central node is treated as any other subscriber and must compete for time on the network; consequently, distributed processing requires a means of controlling access to the network, such as collision detection or collision avoidance. Since all traffic passes through a central node, a failure at this node would affect all subscriber nodes. As with the bus topology, the star topology allows subscribers to be added or dropped without affecting the entire system. The star has an advantage over the bus in that it can be configured to support simultaneous transmissions from more than one node.

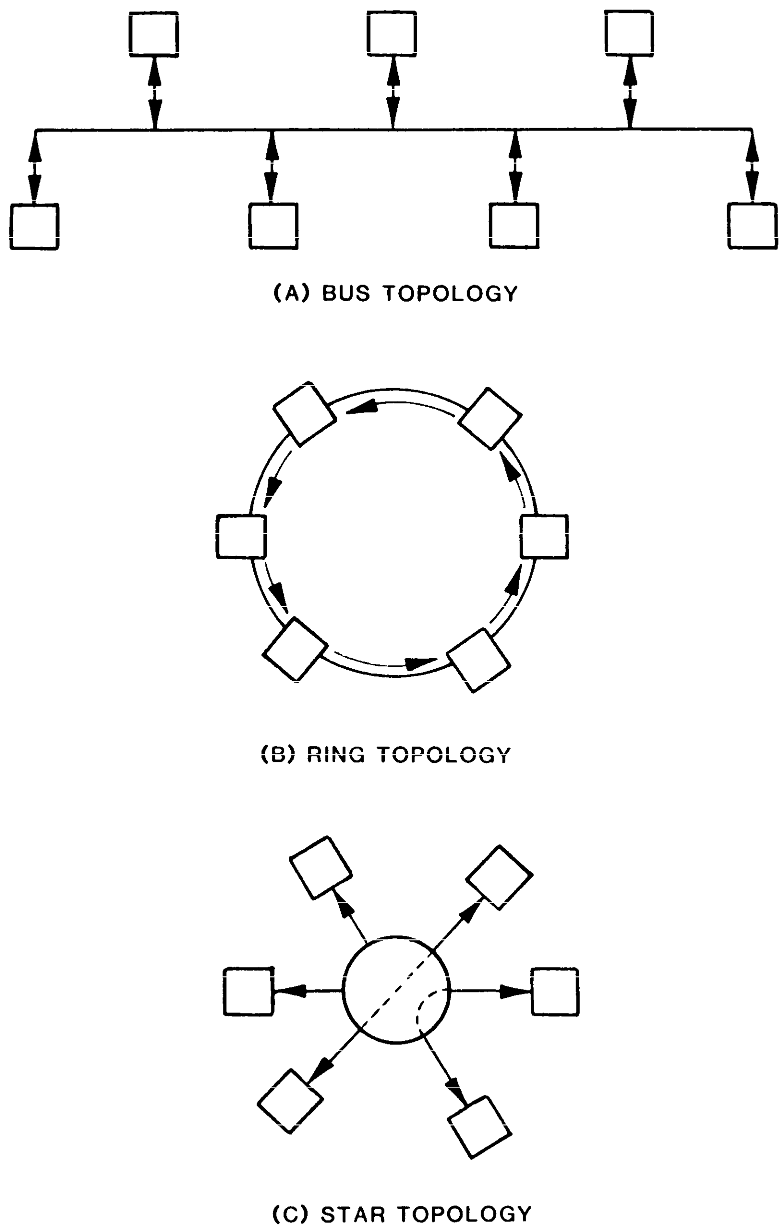


FIGURE E-1. Local area network topologies.

30. **Communications modes.** Information transfer in LANs can be accomplished using one of two modes: baseband or broadband.

30.1 **Baseband.** The baseband mode uses a band of frequencies ranging from almost zero to some maximum frequency (depending on the data rate). All subscribers transmit and receive within this band, and the entire band is used. Digital transmission (as opposed to analog) is used; hence, the transmission distance is limited by dispersion, which distorts the waveform of the signal to the point where it becomes difficult to recognize. In the baseband mode, the information signal does not modulate a carrier signal. Rather, the signal traffic is the information signal itself, sent over the cable as voltage shifts in amplitude. Normally, some form of line driver device is used to impress the signal onto the transmission medium. Technical characteristics of the line driver depend on the data rate and transmission distances. If transmission distances exceed the capabilities of the proposed or available line drivers, repeaters are needed.

30.2 **Broadband.** In the broadband mode, a central rf carrier is modulated by the transmit signal. Additional carriers can be used in a frequency-division multiplex scheme to increase the number of channels available. Each carrier is modulated (amplitude, phase, or frequency) by transmit data signals. A modem (modulator-demodulator) is required at each node to impress the data signal onto a carrier channel. Depending on the complexity (number of carrier channels, network length, and connectivity) of the system, line amplifiers or repeaters may be necessary. Transmission distance is limited by deterioration of the signal-to-noise ratio as the signal passes through many amplifiers. Broadband systems are unidirectional; full-duplex operation is accomplished by assigning separate transmit and receive channels. These channels can be either separate frequencies on a single cable, or physically separate cables. 'Head-end' hardware is used to translate signals from one channel to another. Bus topologies can readily accommodate this equipment at the root of the bus, and hence, are a more practical choice than ring topologies when a broadband system is to be installed.

40. **Transmission media.** The communications medium used in most LANs is either metallic cable (twisted pair or coaxial) or fiber optic cable. Radio transmission can be used, but its use is relatively rare.

40.1 **Twisted pair wiring.** Twisted pair wiring is the least expensive medium available and is the most commonly found communications medium in existing plant installations. Unshielded twisted pairs can support data transmission at rates up to 2 megabits per second (Mbps). Because of their limited bandwidth, unshielded twisted pairs are generally limited to telephone and relatively low-speed data transmission; they are also highly susceptible to EMI and RFI. Shielded, low-capacitance twisted pairs can be used at data rates as high as 5 Mbps, are more reliable than unshielded pairs, and provide better protection from EMI and RFI.

40.2 **Coaxial cable.** Coaxial cable offers a significant increase in performance over twisted pair wiring: baseband data rates up to 20 Mbps, multichannel broadband transmission, capability to support more types of data devices, longer transmission spans, greater protection from EMI and RFI, and better reliability. Coaxial cable is used in broadband systems and high-speed baseband systems that require a medium with greater bandwidth than that provided by twisted pairs. Coaxial cables of different impedances cannot be used together in the trunk of a transmission system. Although coaxial cable and its supporting hardware are more expensive than twisted pair wiring, high-volume use by the cable television industry has lowered the price considerably.

40.3 **Fiber optic cable.** Fiber optic cable provides greater bandwidth than metallic cable, allows longer repeaterless spans, is more reliable, is physically smaller, and is immune to EMI and RFI. Its main disadvantage is high cost; although the cable itself might cost less than coaxial cable, requirements for supporting hardware make the overall cost of fiber optic systems relatively high. Another disadvantage of fiber optic systems is the fact that most existing plant is metallic cable. As the fiber optic industry develops a larger line and reduces costs, fiber optic cable should supplant both twisted pair and coaxial cable for LAN installations. Fibers used in communications can be classed as either multimode or single-mode fibers depending on the number of 'modes' of light propagated in the fiber. Compared to multimode fibers, single-mode fibers have a higher capacity and can be used for longer distances without repeaters. Multimode fibers, however, are usually less expensive, and are suitable at the distances and data rates involved in most LAN applications. Fiber optic cables can be used with metallic cables in so-called 'backbone' systems, in which the main trunks of the network consist of a fiber optic system, while branches from the trunks to individual nodes are metallic cable. Fiber optic systems are usually employed with digital baseband signals, although analog modulation techniques are available for some applications, such as television. Most current fiber optic transmission systems are unidirectional, so that two fibers are needed for full duplex operation. A new technique, wavelength-division multiplexing, will permit full duplex transmission on a single fiber when the equipment becomes available. For more information on fiber optic transmission systems, see MIL-HDBK-415.

APPENDIX F. DATA COLLECTION WORKSHEETS

The worksheets that follow fall into two basic categories:

(1) Worksheets used to record information that is general in nature and must be collected for all sites, regardless of type.

(2) Worksheets geared toward a specific type of site (such as an HF site or an LOS microwave site).

In selecting which of the site-specific worksheets to use, remember to consider the ICF associated with the site. For example, if the ICF for an HF receiver station is an LOS microwave link, then two types of worksheets (HF and microwave) are required.

APPENDIX F, ANNEX A
SITE SURVEY COMMON DATA
Project Identification
(Page 1 of 4)

1. Project identification:

a. Name of project: ______________________________

b. Project identification number: ______________________________

c. Site survey directive: ______________________________

d. Site name or identification: ______________________________

e. Type of telecommunications facility: ______________________________

____

f. Concerned agencies/commands:

(1) Major area command: ______________________________

(2) Operating command: ______________________________

(3) Local command: ______________________________

(4) Construction agency: ______________________________

(5) Communications agency: ______________________________

(6) Local DoD/military frequency manager (if applicable): ______________________________

(7) Other: ______________________________

____

____

2. Survey team:

NAME/TITLE	ORGANIZATION	PHONE
______________ Team Chief	______________	______________
______________ Member	______________	______________
______________ Member	______________	______________

APPENDIX F, ANNEX A
Project Identification
(Page 2 of 4)

______________________ ______________________ ______________________
Member

______________________ ______________________ ______________________
Member

3. Background for survey of this site: ______________________

____

____

____

4. Location:

a. Nearest town/military installation: ______________________

b. Coordinates (UTMG): ______________________

c. Latitude: ______________________ Longitude: ______________________

d. Baseline azimuth survey points (including bearing and distance from proposed site if known): ________

____

e. Altitude and how established: ______________________

____

5. Maps used by survey team:

a. Map title: ______________________
(descriptive name of map)

(1) Series: ______________________

(2) Type: ______________________
(e.g., geodetic, geographic, road)

(3) Territory: ______________________

(4) Publisher: ______________________ Date: ______________________

(5) Scale: ______________________

(6) Special data: ______________________

APPENDIX F, ANNEX A
Project Identification
(Page 3 of 4)

b. Map title: ____________________

(1) Series: ____________________

(2) Type: ____________________

(3) Territory: ____________________

(4) Publisher: ____________________ Date: ____________________

(5) Scale: ____________________

(6) Special data: ____________________

6. Existing facility: ______Yes ______No

If yes, complete remainder of form.

7. Operations and maintenance organization: ____________________

____

Address: ____________________

____

8. Point of contact: ____________________

Local phone: ____________________ AUTOVON: ____________________

9. Sources of information:

If existing documentation, identify each document and items covered: ____________________

____

____

____

If on-site interview, identify persons and items discussed: ____________________

____

____

____

APPENDIX F, ANNEX A
Project Identification
(Page 4 of 4)

If direct observation, identify the observer and areas observed: ______________________

____

____

____

10. Remarks: ____

____

____

____

____

APPENDIX F, ANNEX A
Real Estate Requirements
(Page 1 of 5)

1. Site:

a. Location (attach drawings): ____________________

b. Overall area required: ____________________

2. Site access requirements:

a. Highways:

(1) Distance from intersection of site access road and highway to support base or town:

_______mi (_______km)

(2) Ownership: State _______ County _______ Municipal _______

Other (specify): ____________________

(3) Type of surface: Concrete _______ Asphalt _______ Gravel _______

Stone _______ Dirt _______ Other (specify): _______

(4) Minimum width: _______ft (_______m)

(5) Paved shoulders: _______Yes _______No

(6) Maximum grades: Paved roads ____% Dirt roads ____%

(7) Months of year usable: ____________________

(8) Bridge, tunnel, culvert limits:

Total load: _______tons (_______metric tons)

Load per axle: _______tons (_______metric tons)

Overhead clearance: _______ft (_______m)

Total width: _______ft (_______m) Number of lanes: _______

(9) Improvements required: ____________________

____

____

APPENDIX F, ANNEX A
Real Estate Requirements
(Page 2 of 5)

b. Existing access roads (from site to highways):

(1) Length of access road: __________mi (__________km)

(2) Ownership: State __________ County __________ Municipal __________

Other (specify): ____

(3) Type of surface: Concrete __________ Asphalt __________ Gravel __________

Stone __________ Dirt __________ Other (specify) __________

(4) Minimum width: __________ft (__________m)

(5) Paved shoulders: __________Yes __________No

(6) Maximum grades: Paved roads _____% Dirt roads _____%

(7) Tightness of turns:

Broad (suitable for semitrailer truck) __________

Medium (suitable for 2-1/2-ton military vehicle) __________

Tight (suitable only for compact vehicles) __________

(8) Bridge, tunnel, culvert limits:

Total load: __________tons (__________metric tons)

Load per axle: __________tons (__________metric tons)

Overhead clearance: __________ft (__________m)

Total width: __________ft (__________m) Number of lanes: __________

(9) Months of year usable: ____

(10) Improvements required: ____

____

____

____

APPENDIX F, ANNEX A
Real Estate Requirements
(Page 3 of 5)

c. New access road:

(1) Length required: __________mi (__________km)

(2) Culverts required (number, size, and approximate amount of fill per culvert): __________

____

____

(3) Bridges required (number and approximate span of each): __________

____

____

____

____

(4) Location of required new work: __________

____

(5) Existing tramways: __________Yes __________No

Capacity: __________ft^3 (__________m^3)

__________tons (__________metric tons)

Car dimensions: __________ft (__________m)

3. Real estate description:

a. Legal description of site property: __________

____

b. Present ownership of land:

Name(s) of owner(s):	Address(es):
__________	__________
__________	__________

APPENDIX F, ANNEX A
Real Estate Requirements
(Page 4 of 5)

Agent(s) handling property: ______________________ Address(es): ______________________

______________________ ______________________

NOTE: Inquiries into the availability or cost of privately owned land must be made through the Government agency with land procurement authority (see 5.3.2).

c. Type of acquisition/lease: ______________________

d. Cost of acquisition/lease: ______________________

e. Acquisition of property for access roads:

Name(s) of owner(s): ______________________ Address(es): ______________________

______________________ ______________________

Procedure for acquiring property: ______________________

____

f. Easement requirements:

Government: ______________________

Landlord: ______________________

g. Expansion capabilities: ______________________

____

____

4. Land availability:

a. Maximum area available: ________ ft^2 (________ m^2)

b. Dimensions: ________ft (________m) x ________ft (________m)

c. Legal description: ______________________

____

APPENDIX F, ANNEX A
Real Estate Requirements
(Page 5 of 5)

d. Attach a sketch of the plot boundaries w/dimensions:

____

____

5. Sources of information:

If existing documentation, identify each document and items covered: ______________

____

____

____

If on-site interview, identify persons and items discussed: ______________

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If direct observation, identify the observer and areas observed: ______________

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6. Remarks: ____

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APPENDIX F, ANNEX A
Soil and Drainage
(Page 1 of 2)

1. Data:

a. Name and address of base civil engineer: ____________________

____

b. Name and address of soil core analysis laboratory: ____________________

____

c. Average estimated soil bearing strength: ________ lb/ft^2 (________ kg/m^2)

d. Soil composition by depth: ____________________

e. Soil percolation test results: ____________________

____

f. Water table depth estimate: ________ ft (________ m)

g. Drainage (runoff) conditions: ____________________

____

____

h. Flooding history/potential: ____________________

____

____

i. Civil works required: ____________________

____

2. Sources of information:

If existing documentation, identify each document and items covered: ____________________

____

____

____

APPENDIX F, ANNEX A
Soil and Drainage
(Page 2 of 2)

If on-site interview, identify persons and items discussed: ______________________

____

____

____

If direct observation, identify the observer and areas observed: ______________________

____

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3. Remarks: ____

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APPENDIX F, ANNEX A
Weather and Seismic Activity
(Page 1 of 3)

1. Area environmental conditions:

a. Name and location of weather station: ______________________________

____

Station elevation: __________ft (__________m)

Distance from site: __________mi (__________km)

b. Maximum frostline depth at site: __________ft (__________m)

c. Describe site's unusual weather phenomena (monsoons, hurricanes, tornados, sandstorms, and detrimental effects of seashore, industrial pollutants, and smoke):

d. Seismic zone: ______________________________

Describe any unusual seismic activity at site: ______________________________

____

____

____

Frequency of tremors: __________ Frequency of damaging quakes: __________

Date of latest damaging earthquake: ______________________________

Richter (or other) scale intensity: ______________________________

Duration: __________min __________sec

Location of epicenter: ______________________________

Distance from site: __________mi (__________km) Direction from site: __________

Distance from site to nearest damaged structure: __________mi (__________km)

e. Lightning activity: __________ thunderstorm days per year.

APPENDIX F, ANNEX A
Weather and Seismic Activity
(Page 2 of 3)

2. Climate:

Rainfall: Maximum recorded: ________in. (________mm) ________mo ________yr
Give monthly average in (*circle one*) in. or mm:
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Snowfall: Maximum recorded: ________in. (________mm) ________mo ________yr
Give monthly average in (*circle one*) in. or mm:
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Humidity:
Give monthly percent relative humidity:
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Temperature: Maximum recorded: ________°F (________°C) ________mo ________yr
Give monthly average in (*circle one*) °F or °C:
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Wind: Maximum recorded: ________mph (________kmph) ________mo ________yr
Give monthly average in (*circle one*) mph or kmph:
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Give prevailing direction(N, NE, E, etc.):
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Frequency of winds over 10 mph (16 kmph):
Give number of days per month:
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Frequency of winds over 15 mph (24 kmph):
Give number of days per month:
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

Frequency of winds over 20 mph (32 kmph):
Give number of days per month:
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

APPENDIX F, ANNEX A
Weather and Seismic Activity
(Page 3 of 3)

3. Sources of information:

If existing documentation, identify each document and items covered: ______________________

____

____

____

If on-site interview, identify persons and items discussed: ______________________

____

____

____

If direct observation, identify the observer and areas observed: ______________________

____

____

____

4. Remarks: ____

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____

APPENDIX F, ANNEX A
Topography and Terrain
(Page 1 of 1)

1. Site elevation (above mean sea level):

High: ________ft (________m) Low: ________ft (________m)

2. General description:

Vegetation: Heavy ________ Light ________ None ________

Trees: Heavily wooded ________ Lightly wooded ________ None ________

Slopes: Steep ________ Gentle ________ Rolling ________ Flat ________

Surface characteristics: Rock ________ Gravel ________ Sand ________

Clay ________ Other ________

3. Sources of information:

If existing documentation, identify each document and items covered: ________

____

____

____

If on-site interview, identify persons and items discussed: ________

____

____

____

If direct observation, identify the observer and areas observed: ________

____

____

____

4. Remarks: ________

____

____

____

APPENDIX F, ANNEX A
Photographs
(Page 1 of 1)

1. Panoramic photographs (use stadia rod adjusted to camera height and chalkboard to indicate the scale and azimuth reference of each exposure).

Photo No.	Date taken	Azimuth	Remarks

2. Other photographs: ______________________

APPENDIX F, ANNEX A
Facilities Construction
(Page 1 of 6)

1. Construction period:

From ____________ to ____________

2. Local laws and customs affecting construction: ____________

____

____

3. Personnel work force constraints: ____________

____

____

4. Minimum overall site area required:

______ft (______m) x ______ft (______m)

5. Buildings:

	Present size	Size of new building or proposed addition
Building #1: Type: ______	______ft^2 (______m^2)	______ft^2 (______m^2)
Building #2: Type: ______	______ft^2 (______m^2)	______ft^2 (______m^2)
Building #3: Type: ______	______ft^2 (______m^2)	______ft^2 (______m^2)
Building #4: Type: ______	______ft^2 (______m^2)	______ft^2 (______m^2)

6. Transportable shelters/vans:

	Present facilities	Proposed new facilities
Shelter/van #1: Type: ______	______ft^2 (______m^2)	______ft^2 (______m^2)
Shelter/van #2: Type: ______	______ft^2 (______m^2)	______ft^2 (______m^2)

APPENDIX F, ANNEX A
Facilities Construction
(Page 2 of 6)

Shelter/van #3:
Type: ________ ______ft^2 (______m^2) ______ft^2 (______m^2)

Shelter/van #4:
Type: ________ ______ft^2 (______m^2) ______ft^2 (______m^2)

7. New facility requirements:

a. Architectural (technical equipment area):

(1) Floor requirements:

(a) Panel size: ______ft^2 (______m^2)

(b) Design loading, uniform: ______lb/ft^2 (______kg/m^2)

(c) Design loading, concentrated: ______lb (______kg)

(d) Allowable deflection: ________________________________

(e) Height above subfloor: ______in. (______cm)

(f) Raised-floor air register:

______in. (______cm) x ______in. (______cm)

(g) Special requirements: ________________________________

____

____

(2) Door requirements: ________________________________

____

____

(3) Window requirements: ________________________________

____

____

(4) Ceiling requirements:

Height: ______ft ______in. (______m ______cm)

Acoustic treatment: ________________________________

APPENDIX F, ANNEX A
Facilities Construction
(Page 3 of 6)

b. Environmental control:

(1) Equipment space interior ambient conditions:

Temperature: ________°F (________°C), ± ________°F (________°C)

Humidity: ________% relative humidity, ± ________%

(2) Special equipment requirements:

(a) Transmitter equipment:

Temperature: ________°F (________°C)

Air flow: ________ft^3/min (________m^3/min)

Pressure differential: ________psi (________Pa)

(b) Other communications equipment:

Temperature: ________°F (________°C)

Air flow: ________ft^3/min (________m^3/min)

Pressure differential: ________psi (________Pa)

(c) Other equipment (specify): ________________________________

Temperature: ________°F (________°C)

Air flow: ________ft^3/min (________m^3/min)

Pressure differential: ________psi (________Pa)

(d) Other equipment (specify): ________________________________

Temperature: ________°F (________°C)

Air flow: ________ft^3/min (________m^3/min)

Pressure differential: ________psi (________Pa)

(3) Total equipment cooling requirement:

Heat dissipation:

Transmitter equipment area: ________Btu/hr (________joules/hr)

Communications equipment area: ________Btu/hr (________joules/hr)

Other areas: ________Btu/hr (________joules/hr)

Air flow:

Transmitter equipment area: __________ft^3/min (__________m^3/min)

Communications equipment area: __________ft^3/min (__________m^3/min)

Other areas: __________ft^3/min (__________m^3/min)

(4) Air filtration and circulation requirements: ______________________________

____

____

NOTE: The ASHRAE load calculation form contained in appendix A of ASHRAE GRP 158, *Cooling and Heating Load Calculation Manual*, may be substituted for, or used in conjunction with, the completion of the above information.

8. Existing building/floor space:

a. Building existing: __________Yes __________No

b. Suitable for planned use: ____________________ (e.g., earth terminal, ICF) __________Yes __________No

c. Size: __________ft (__________m) x __________ft (__________m)

d. Available floor space: __________ft^2 (__________m^2)

Dimensions: __________ft (__________m) x __________ft (__________m)

__________ft (__________m) x __________ft (__________m)

__________ft (__________m) x __________ft (__________m)

__________ft (__________m) x __________ft (__________m)

e. Type construction:

Permanent: ______________________________
(e.g., masonry, brick, frame)

Temporary: ______________________________
(e.g., prefabricated)

APPENDIX F, ANNEX A
Facilities Construction
(Page 5 of 6)

9. Antenna(s):

a. Dimensions: __________ft (__________m) x __________ft (__________m)

b. Expansion capability: ______________________________

____

____

____

c. Tower required: __________Yes __________No

Height: __________ft (__________m)

Base area: __________ft (__________m) x __________ft (__________m)

d. Radome required: __________Yes __________No

Height: __________ft (__________m)

Base area: __________ft (__________m) x __________ft (__________m)

e. Antenna frontal clearance required: __________ft (__________m)

f. Antenna/building separation required: __________ft (__________m)

10. Sources of information:

If existing documentation, identify each document and items covered: ______________________________

____

____

____

If on-site interview, identify persons and items discussed: ______________________________

____

____

____

APPENDIX F, ANNEX A
Facilities Construction
(Page 6 of 6)

If direct observation, identify the observer and areas observed: ______________________

____

____

____

11. Remarks: ______________________________________

____

____

____

APPENDIX F, ANNEX A
Grounding, Bonding, and Shielding
(Page 1 of 5)

NOTE: For more information on grounding, bonding, and shielding, see MIL-HDBK-419, Volume II.

1. Earth electrode subsystem:

a. Soil resistivity (if known): __________ohm/in.^{3} (__________ohm/cm.^{3})

b. Resistance of completed earth electrode subsystem (if an established site): __________ohms.

c. Configuration:

Attach drawing of proposed or existing system showing dimensions, locations of buried metal objects, risers for lightning, power, or signal ground connections, and ground wells.

d. Materials and installation:

Rod size and length: ______________________________

Rod composition: ______________________________

Counterpoise cable size: ______________________________

Counterpoise cable depth: ______________________________

Grounding conductor size and length: ______________________________

Grounding conductor composition: ______________________________

Ground wells: __________Yes __________No Type: ______________________________

2. Lightning protection network:

a. Cone of protection:

Attach profile views of facility cone of protection.

b. UL Master Label obtained? __________Yes __________No __________Not required

c. Layout:

Attach drawings.

d. Air terminals:

Materials: ______________________________

Height: ______________________________

Placement: ______________________________

APPENDIX F, ANNEX A
Grounding, Bonding, and Shielding
(Page 2 of 5)

e. Roof conductors:

Materials: ____________________

Size: ____________________

Routing: ____________________

f. Down conductors:

Materials: ____________________

Building structure: __________ or Separate conductors __________

Conductor size: ____________________

g. Hardware and fasteners:

Materials: ____________________

Mounting: ____________________

Guards: ____________________

3. Fault-protective ground network:

a. Attach sketch or drawings.

Include transformer connections and neutral connection at service disconnect (main breaker). Indicate wire sizes, connection points, connector sizes, use of conduit, cable trays, etc.

b. Record below, or indicate on the above drawing, connections to the earth electrode subsystem.

Connection	Location	Length and size of cable

APPENDIX F, ANNEX A
Grounding, Bonding, and Shielding
(Page 3 of 5)

c. Narrative description of fault-protective network: ______________________

____

____

____

4. Signal reference ground:

a. Configuration:

Attach drawing.

b. Main ground plates:

Location: ______________________

Size: ______________________

Mounting: ______________________

c. Branch ground plates:

Location: ______________________

Size: ______________________

Mounting: ______________________

d. Feeder ground plates:

Location: ______________________

Size: ______________________

Mounting: ______________________

e. Trunk cable:

Routing: ______________________

Size: ______________________

Length: ______________________

f. Branch cable:

Routing: ______________________

Size: ______________________

Length: ______________________

APPENDIX F, ANNEX A
Grounding, Bonding, and Shielding
(Page 4 of 5)

g. Labels and covers: ______________________________

h. Surge arresters: ______________________________

5. Bonding. Describe bonding materials, techniques, and cautions for each of the four subsystems of the facility ground:

____
____
____
____
____
____
____
____
____
____

6. Shielding. Describe existing shielded enclosures and any shielding provided by the existing structure. If shielded enclosures are to be constructed, attach engineering drawings or a sketch of the design:

____
____
____
____
____
____
____
____
____

APPENDIX F, ANNEX A
Grounding, Bonding, and Shielding
(Page 5 of 5)

7. Test equipment. List the equipment needed to evaluate existing ground systems or to gather data for design of new facility ground systems:

8. Sources of information:

If existing documentation, identify each document and items covered:

If on-site interview, identify persons and items discussed:

If direct observation, identify the observer and areas observed:

9. Remarks:

APPENDIX F, ANNEX A
Soil Resistance
(Page 1 of 2)

1. Type of soil: ______________________________

2. Weather conditions (weather conditions at time of measurement and general statement about precipitation in past week):

____

3. Previous soil resistivity measurement: ______________________________

Date: ______________

4. Other observations: ______________________________

5. Location of measurement (describe)	Depth and spacing of rods	Resistance reading (ohms)
	6 in.; 10 ft (15 cm; 3m)	
	12 in.; 20 ft (30 cm; 6 m)	
	18 in.; 30 ft (optional) (45 cm; 9 m)	
	6 in.; 10 ft (15 cm; 3m)	
	12 in.; 20 ft (30 cm; 6 m)	
	18 in.; 30 ft (optional) (45 cm; 9 m)	
	6 in.; 10 ft (15 cm; 3m)	
	12 in.; 20 ft (30 cm; 6 m)	
	18 in.; 30 ft (optional) (45 cm; 9 m)	

6. Sources of information:

If existing documentation, identify each document and items covered: ______________________________

____

____

____

APPENDIX F, ANNEX A
Soil Resistance
(Page 2 of 2)

If on-site interview, identify persons and items discussed: ____________________

____

____

____

If direct observation, identify the tester and date of tests: ____________________

____

____

____

7. Remarks: ____________________

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APPENDIX F, ANNEX A
Utilities Availability
(Page 1 of 5)

1. Electric power:

Commercial or base supply (name, address, and telephone number of supplying company or base engineer):

____

a. Primary feed (to nearest available point of connection):

Voltage: ________ Frequency: ________ Phase: ________ Wires: ________

kW available for new facility: ________

Will available power be sufficient for new facility? ________Yes ________No

If no, approximate cost to the Government for upgrade: ________________

Regulation: ____________ Voltage: ________ Frequency: ________

Power outages: Number per year: ________ Duration: ________

Distance to nearest point of connection (line transformer or substation) where power can be tapped:

____

Cost: $________per kWh

Does this include high-volume discount? ________Yes ________No

Are power cables underground or overhead? ________________

b. Secondary feed (to nearest available point of connection; obtain distribution and switching diagram if possible and attach to this worksheet):

Voltage: ________ Frequency: ________ Phase: ________ Wires: ________

kW available for new facility: ________ Cost: $________per kWh

Is the feeder continuously energized? ________Yes ________No

c. Auxiliary power:

Is an auxiliary power supply available? ________Yes ________No

Type of generator: ________________

Where is it located? ________________

APPENDIX F, ANNEX A
Utilities Availability
(Page 2 of 5)

Voltage: __________ Frequency: __________ Phase: __________ Wires: __________

Is switching manual or automatic? ______________________________

If a commercial source is used, is there a standby charge? __________Yes __________No

Cost: $__________

2. Water supply:

a. Potable:

Nearest available source: ______________________________

Chemical and bacteriological analysis: ______________________________

____

Name, address, and telephone number of analyst: ______________________________

____

Source: Stream __________ Lake __________ Well __________ Piped __________

Other (specify): ______________________________

Reliability of supply: ______________________________

Present available maximum daily supply: __________gpm (__________Lpm)

If existing pipeline:

Pressure: __________psi (__________Pa)

Pipe size: __________in. (__________cm)

If well:

Location: ______________________________

Depth: ______________________________

Condition: ______________________________

Availability of drawings, layouts, and schematics of present water distribution system in the area of the site:

____

APPENDIX F, ANNEX A
Utilities Availability
(Page 3 of 5)

Required modifications to the existing system to meet the requirements of the new facility: __________

____

Cost delivered to site: $__________per gal ($__________per liter)

b. Other available water:

Source: Lake __________ River __________ Well __________

Other (specify): ____________________ None: ____________________

Name and address of owner: ______________________________________

____

____

Distance to supply: __________mi (__________km)

Elevation of supply relative to site: __________ft (__________m) _____higher _____lower

Is water from this source being delivered to the site? __________Yes __________No

If yes, how? ____

____

3. Sewage disposal:

a. If an existing site, give the sewage flow capacity of the present system: __________gpm (__________Lpm)

b. For a new site:

(1) If a nearby sewage system is available, provide system flow capacity and a sketch of required construction needed to gain system access,

or

(2) Record the results of a septic system soil percolation test.

____

____

4. Gas:

Name, address, and telephone number of gas company: ______________________

____

APPENDIX F, ANNEX A
Utilities Availability
(Page 4 of 5)

Distance to nearest gas line: ______________________________

Pipeline pressure: __________psi (__________Pa)

Pipeline capacity: __________ft^3/min __________m^3/min)

Service reliability: ______________________________

Availability of drawings, layouts, and schematics of present gas distribution system in the area of the site:

____

Possibility of modification or extension of present gas distribution system: ______________________________

____

Required modifications, construction, and equipment: ______________________________

____

____

5. Telephone service:

Military __________ Commercial __________

Distance to nearest telephone service connection: __________mi (__________km)

Type of construction:

Open wire __________ Aerial cable __________ Buried cable __________

Number of pairs available: __________

Wire gauge of pairs: __________

Estimated cost of line extension:

Open wire: $__________ Aerial cable: $__________ Buried cable: $__________

If on an existing base, type of base exchange switchboard: ______________________________

____

Number of lines: __________ Number of line drops unassigned: ______________________________

APPENDIX F, ANNEX A
Utilities Availability
(Page 5 of 5)

Number of trunks to each connecting base: ______________________________

____

____

____

____

6. Sources of information:

If existing documentation, identify each document and items covered: ____________________

____

____

____

If on-site interview, identify persons and items discussed: ____________________

____

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____

If direct observation, identify the observer and areas observed: ____________________

____

____

____

7. Remarks: ____

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____

APPENDIX F, ANNEX A
Existing or Proposed Power Loading Characteristics
(Page 1 of 6)

1. Ac power sources:

a. Primary:

Voltage: __________Vac ± __________% Frequency: __________Hz ± __________%

Phases: __________ Maximum power deliverable: __________kW

b. Auxiliary:

Class (B and C) from table C-I: __________

Voltage: __________Vac ± __________% Frequency: __________Hz ± __________%

Phases: __________ Maximum power deliverable: __________kW

c. UPS:

Type (flywheel, battery, etc.): ______________________________

Voltage: __________Vac ± __________% Frequency: __________Hz ± __________%

Phases: __________ Maximum power deliverable: __________kW

2. Demand voltage and current:

Equipment/load	Line-to-neutral voltage (rms volts)	Phase current (amperes)	Power (kW)	Power factor

APPENDIX F, ANNEX A
Existing or Proposed Power Loading Characteristics
(Page 2 of 6)

3. Site power load:

a. Average station load:

High: __________kW   Low: __________kW

NOTE: The high average is the average load with high-demand equipment (such as air-conditioners or heaters) turned on. The low average is the average load with the high-demand items turned off.

b. Peak station load:

Value: __________kW   Duration: __________ seconds

Station load balance: __________%

c. Projected load:

Increase		Decrease	
Equipment added	kW	Equipment removed	kW

APPENDIX F, ANNEX A
Existing or Proposed Power Loading Characteristics
(Page 3 of 6)

4. Outage record, primary power:

Date	Time	Duration	Remarks

5. Auxiliary power source:

Equipment description: ______

Operation description: ______

6. Ac power distribution system description: ______

7. Existing power analysis:

Line	Primary Power	Auxiliary power
Average voltage:		
Low average	______	______
High average	______	______
Sags:		
Sags per hour	______	______
Sag voltage	______	______
Sag duration	______	______
Surges:		
Surges per hour	______	______
Surge voltage	______	______
Surge duration	______	______
Impulses:		
Impulses per hour	______	______
Impulse voltage	______	______

APPENDIX F, ANNEX A
Existing or Proposed Power Loading Characteristics
(Page 4 of 6)

8. Existing power noise characteristics:

Load condition	Date/time	Waveform sketch w/magnitude	Remarks

APPENDIX F, ANNEX A
Existing or Proposed Power Loading Characteristics
(Page 5 of 6)

9. Uninterruptible power supply (UPS):

Characteristic		Specified value	Measured value
Input:	Voltage	____________	____________
	Current	____________	____________
	Bypass voltage	____________	____________
	Bypass current	____________	____________
	Power factor	____________	____________
	Total current distortion	____________	____________
	Current limit	____________	____________
Output:	Power	____________	____________
	Voltage	____________	____________
	Phase voltage harmonic distortion	____________	____________
	Phase separation	____________	____________
	Overload current	____________	____________
	Fault current	____________	____________
	Regulation	____________	____________
	Voltage transient response	____________	____________
	Voltage transient recovery time	____________	____________
	Load balance	____________	____________
	System efficiency	____________	____________

APPENDIX F, ANNEX A
Existing or Proposed Power Loading Characteristics
(Page 6 of 6)

10. Sources of information:

If existing documentation, identify each document and items covered: ____________________

____

____

____

If on-site interview, identify persons and items discussed: ____________________

____

____

____

If direct observation, identify the observer and areas observed: ____________________

____

____

____

11. Remarks: ____________________

____

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APPENDIX F, ANNEX A
Administrative and Logistical Support
(Page 1 of 9)

1. Personnel Support:

a. Housing availability (officer, enlisted, DoD civilian, contractor):

On-base housing, bachelor and family:

Type and quality: ______________________

Method of assignment: ______________________

Waiting time: ______________________

Availability of furnishings: ______________________

Off-base housing:

Type and quality: ______________________

Location: ______________________

b. Personnel services:

Administrative:

Location: ____________ Distance: ________mi (________km)

Finance:

Location: ____________ Distance: ________mi (________km)

c. Medical and dental facilities:

Military:

Location: ____________ Distance: ________mi (________km)

Commercial:

Location: ____________ Distance: ________mi (________km)

d. Military exchange:

Location: ____________ Distance: ________mi (________km)

Size: ______________________

Type of stockage: ______________________

____

APPENDIX F, ANNEX A
Administrative and Logistical Support
(Page 2 of 9)

e. Commissary:

Location: ________________ Distance: ________mi (________km)

f. Schools (distance and grades taught):

On-base: ________________

Off-base: ________________

Existing: Grade school ________ High school ________ College ________

Private tutors: ________Yes ________No

Distance: ________mi (________km)

Standards: Excellent ________ Adequate ________ Inadequate ________

Sponsor: Government ________ Private ________ Municipal ________

Name of sponsor: ________________

Availability of school transportation: ________________

g. Mess facilities (officer, enlisted, DoD civilian, contractor):

On-site: ________________

Off-site: ________________

Local restaurants: ________Yes ________No

Prices compared to U.S.:

________Percent higher ________Percent lower ________Same

h. Hotels:

Availability: Plentiful ________ Scarce ________ None ________

Quality: Excellent ________ Adequate ________ Poor ________

Lodging, average price per day: ________

Food, average price per day: ________

APPENDIX F, ANNEX A
Administrative and Logistical Support
(Page 3 of 9)

i. Private homes:

Availability: Plentiful ________ Scarce ________ None ________

Accommodations: Excellent ________ Adequate ________ Poor ________

Average price per month: ________furnished ________unfurnished

j. Utilities:

Type available and approximate cost:

Heating (oil, electric, other): ____

Electricity: ____

Voltage ________ Frequency ________ Reliability ________

Telephone service (availability and cost): ____

____

k. Recreation (television, radio, sports, hobbies, movies):

On-base: ____

Off-base: ____

l. Churches:

On-base: ____

Off-base: ____

m. Clothing supplies:

Local merchants: Plentiful ________ Scarce ________ None ________

Prices compared to U.S.: ________Percent higher ________Percent lower ________Same

n. Banking:

On-base: ____

Off-base: ____

Local banks: Plentiful ________ Scarce ________ None ________

2. Logistical support:

a. Engineering agencies:

(1) Facility/base civil/public works engineer:

Point of contact: ______________________________

Local phone: ______________ AUTOVON: ______________

Address: ______________________________

____

(2) Army Corps of Engineers/Air Force Engineering and Services Directorate/Naval Facilities Engineer Command:

Point of contact: ______________________________

Local phone: ______________ AUTOVON: ______________

Address: ______________________________

____

(3) Other: ______________________________

Local phone: ______________ AUTOVON: ______________

Address: ______________________________

____

b. Petroleum, oil, and lubricants:

Total storage area required: __________ ft^2 (__________ m^2)

Required storage capacity:

Gas: __________ gal (__________ L)

Diesel: __________ gal (__________ L)

Heating oil: __________ gal (__________ L)

c. Maintenance area required (include sketch): __________ ft^2 (__________ m^2)

APPENDIX F, ANNEX A
Administrative and Logistical Support
(Page 5 of 9)

d. Operations and maintenance organization:

Point of contact: ____________________

Local phone: ____________________ AUTOVON: ____________________

Address: ____________________

____

e. Communications:

(1) Telephone: See utilities worksheet, page 106.

(2) Radio:

Service to nearest military base:

Name of base: ____________________

Type of service (commercial or military): ____________________

Type of radio link (HF, LOS, etc.): ____________________

Frequencies: ____________________

Number of channels: ________Voice ________Data at ________bps

________Teletype at ________wpm

Service to area command headquarters:

Name and location of headquarters: ____________________

____

Type of service (commercial or military): ____________________

Type of radio link (HF, LOS, etc.): ____________________

Frequencies: ____________________

Number of channels: ________Voice ________Data at ________bps

________Teletype at ________wpm

Access to the Defense Communications System:

Type of radio link (HF, LOS, etc.): ____________________

Frequencies: ____________________

Number of channels: ________Voice ________Data (________bps)

________Teletype at ________wpm

(3) Communications services available to construction contractor:

Will the contractor be permitted to use Government-owned or -operated communications facilities during the construction and installation phase?

____

If such use is permitted, what is the approximate charge?

____

Will mobile and portable equipment be available during the installation?

____

(4) Secure communications:

Will secure communications facilities for off-base circuits be required?

During construction and installation? ____________________

After installation? ____________________

Transportation:

(1) Access waterway:

Open sea ________ River________ Canal ________ Lake ________ Bay ________

Name(s): ____________________

Channel depths: ____________________

Mean low water level: ________ft (________m)

APPENDIX F, ANNEX A
Administrative and Logistical Support
(Page 7 of 9)

Mean high water level: ________ft (________m)

Name and location of harbor(s) nearest to site: ____________________

____

Docking facilities: Good ________ Poor ________

Vessel size limitation: ____________________

Reliability (months of year usable): ____________________

Route from dock to site (include distance): ____________________

____

Names of shipping companies and local business addresses: ____________________

____

____

(2) Railroads:

Name and address of railroad owning nearest siding:

____

Reliability (months of year usable): ____________________

Route from siding to site (include distance): ____________________

____

Name and address of railroad owning nearest terminal:

____

Facilities: Passenger ________ Freight ________

Reliability (months of year usable): ____________________

Route from terminal to site (include distance): ____________________

____

APPENDIX F, ANNEX A
Administrative and Logistical Support
(Page 8 of 9)

(3) Trucking:

Names and addresses of nearest commercial firms:

____

____

Limitations on material handling (if any): ______________________________

____

____

(4) Passenger service to and from nearest support base or town:

Bus ________ Taxi ________ Rental auto ________ None ________

(5) Airfields:

Names and addresses of airfields in area:

____

____

Ownership: Government ________ Municipal ________ Private ________

Terminal facilities: Passenger ________ Freight ________

Maximum size of plane accommodated: ______________________________

Names and addresses of commercial carriers:

____

____

____

Route from airport to site (include distance): ______________________________

____

Reliability (months of year usable): ______________________________

APPENDIX F, ANNEX A
Administrative and Logistical Support
(Page 9 of 9)

3. Sources of information:

If existing documentation, identify each document and items covered: ____________________

____

____

____

If on-site interview, identify persons and items discussed: ____________________

____

____

____

If direct observation, identify the observer and areas observed: ____________________

____

____

____

4. Remarks: ____

____

____

____

APPENDIX F, ANNEX A
Nuclear Survivability
(Page 1 of 9)

WARNING

When information is entered, this form may require a security classification. To determine the security classification, consult (1) the operating command security officer for existing sites, or (2) the project security classification guide for new sites.

1. Ac power, external network:

a. Site access lines:

Surface: __________

Buried: __________ If buried, state the depth: __________

Aerial: __________

Combination: ____

Voltage: Primary: __________V Secondary: __________V

Protection:

Steel conduit: __________ Size: __________

Plastic conduit: __________ Size: __________

Reinforced concrete: __________ Size: __________

Other: ____

Reinforcement: ____

Ground location: ____

Arrester configuration: ____

b. Building access lines, surface:

(1) Support structure:

Construction: Steel: __________ Wood: __________ Other: __________

Spacing: ____

Ground point location: ____

APPENDIX F, ANNEX A
Nuclear Survivability
(Page 2 of 9)

WARNING

When information is entered, this form may require a security classification. To determine the security classification, consult (1) the operating command security officer for existing sites, or (2) the project security classification guide for new sites.

(2) Conductors:

Numbers: ______________________________

Arrangement on support structure: ______________________
(vertical, horizontal)

Spacing (distance): ____________ Avg height above ground: ____________

Neutral ______________ or Guard wire ______________

Position: ______________________________

Neutral or guard wire grounded? ______________________

Method: ______________________________

Spacing (distance): ______________________________

(3) Method: ______________ Place: ______________

Protection devices: ______________________________

Manufacturer: ______________ Part no.: ______________

(4) Branch connection to other facilities within 1/4 mi (1/2 km) of site (technical control, AUTOVON site, etc.):

Distance from site: ______________________________

Describe branch point (indicate point by line drawing):

Branch load: ______________________________

APPENDIX F, ANNEX A
Nuclear Survivability
(Page 3 of 9)

WARNING
When information is entered, this form may require a security classification. To determine the security classification, consult (1) the operating command security officer for existing sites, or (2) the project security classification guide for new sites.

Describe branch load feeder point: ______________________________

____

____

(5) Site feeder pole:

Distance from: Site penetration: __________ Site transformer: __________

Conductor routing to transformer: Buried: ________ Surface: ________

If surface, describe conductor routing to transformer: ____________________

____

(6) Describe building penetration by conductor (including weatherhead):

____

____

c. Building access lines, buried:

(1) Conduit construction:

Steel: ________ Concrete: ________ Plastic: ________

Size (diameter): ________ Conduit vertical length (show sketch of masthead conduit details):

____

(2) Manufacturer: ____________________ Type: ____________________

Part no.: ____

(3) Describe building penetration by conductor: ______________________________

____

____

WARNING

When information is entered, this form may require a security classification. To determine the security classification, consult (1) the operating command security officer for existing sites, or (2) the project security classification guide for new sites.

d. Site transformers:

Manufacturer: ______________________ Part no.: ______________________

Voltage: Primary: ______________________ Secondary: ______________________

Rating: ______________________(kVA) Power factor: ______________________

Number of transformers: ______________________ Number of stages: ______________________

Connectivity (Δ or Y): Primary: ______________________ Secondary: ______________________

Location: Pole: __________ Ground: __________ Buried: __________

Grounding: Primary: ______________________ Secondary: ______________________

Transformer case: ____

Number of conductors: Primary: ______________________ Secondary: ______________________

e. Unique features of ac power system (external network) not described by data above (use sketches and photographs as required):

____

____

____

____

____

2. Ac power, internal network:

Update existing drawings or provide a sketch of the internal ac power distribution network. Include details of the distribution panels, conduit or duct network, protective devices, wire and cable details, and other data. Take photographs as necessary to show details of routing, panel wiring, and wall penetrations. Indicate separate power runs for critical equipment and noncritical equipment (e.g. air-conditioners). Indicate wire or cable distribution on drawing with size, insulation type, and number of conductors.

APPENDIX F, ANNEX A
Nuclear Survivability
(Page 5 of 9)

WARNING

When information is entered, this form may require a security classification. To determine the security classification, consult (1) the operating command security officer for existing sites, or (2) the project security classification guide for new sites.

a. Protection (include size and material):

Rigid conduit: ______________________

Thin-wall conduit: ______________________

Flexible conduit: ______________________

Plastic conduit: ______________________

Duct or tray type: ______________________

Other (specify): ______________________

b. Distribution scheme:

Separation from communication cables: ______________________

Overhead distance from floor: ______________________

Floor duct size and depth: ______________________

Subfloor or raised floor: ______________________

Lengths of runs between panels or between panel and load: ______________________

____

c. Equipment control and power distribution panels:

Conduit connections (show detail on photographs): ______________________

Wall mounting (show sketch or photography): ______________________

Panel type and size: ______________________

Protective devices (arresters, fuses, circuit breakers. etc.):

Type: ______________ Capacity: ______________

WARNING

When information is entered, this form may require a security classification. To determine the security classification, consult (1) the operating command security officer for existing sites, or (2) the project security classification guide for new sites.

Wire sizes: ______________________

Arrangement of phase, neutral, or ground leads: ______________________

d. Ac power filters:

Type: __________ Manufacturer: __________ Part No.: __________

Location: ______________________

Installation details (describe or sketch connections and mounting):

____

____

Protective devices:

Primary: __________ Type: __________

Manufacturer: __________ Part no.: __________

Secondary: __________ Type: __________

Manufacturer: __________ Part no.: __________

Distance from transformer terminals to weatherhead: ______________________

Distance from weatherhead to main circuit breaker: ______________________

3. Dc power:

Update existing drawings or provide a detailed sketch of the uninterruptible power supply (UPS) and dc power system:

a. Equipment (inverters, rectifiers):

Type: Manufacturer: ______________________ Part No.: __________

APPENDIX F, ANNEX A
Nuclear Survivability
(Page 7 of 9)

WARNING

When information is entered, this form may require a security classification. To determine the security classification, consult (1) the operating command security officer for existing sites, or (2) the project security classification guide for new sites.

Location of support racks or cabinets: ______

______

Grounding details: ______

______

b. Distribution and control panels:

Type: ______

Protective devices: ______ Manufacturer: ______ Part No.: ______

Loads (describe loads on each branch): ______

______

Grounding details: ______

______

c. Conductors:

Number and routing (describe arrangement, methods of mounting or attaching wires to structures, use of conduit):

Conduit type: ______

Wire size and type: ______

d. Battery facility:

Connectivity from charging equipment: ______

Connectivity from batteries: ______

Batteries (number and type): ______

Manufacturer and part number: ______

End-cell arrangement: ______

APPENDIX F, ANNEX A
Nuclear Survivability
(Page 8 of 9)

WARNING

When information is entered, this form may require a security classification. To determine the security classification, consult (1) the operating command security officer for existing sites, or (2) the project security classification guide for new sites.

4. Grounding and shielding (see worksheet beginning on page 95):

5. Nuclear hardening:

Has site been designated as hardened installation? ________Yes ________No

If yes, complete remainder of worksheet.

a. Degree of hardness required: ________psi (________Pa)

b. Fallout protection required? ________Yes ________No

c. For how long? ________hours ________days

d. Distance from site to potential targets:

(1) Target #1 ID: ____________________ Distance: ________mi (________km)

(2) Target #2 ID: ____________________ Distance: ________mi (________km)

(3) Target #3 ID: ____________________ Distance: ________mi (________km)

(4) Target #4 ID: ____________________ Distance: ________mi (________km)

6. Sources of information:

If existing documentation, identify each document and items covered: ____________________

____

____

____

If on-site interview, identify persons and items discussed: ____________________

____

____

____

APPENDIX F, ANNEX A
Nuclear Survivability
(Page 9 of 9)

WARNING

When information is entered, this form may require a security classification. To determine the security classification, consult (1) the operating command security officer for existing sites, or (2) the project security classification guide for new sites.

If direct observation, identify the observer and areas observed: ______________________

____

____

____

7. Remarks: ____

____

____

____

APPENDIX F, ANNEX B
Tropospheric Scatter - LOS - Satellite Stations
(Page 1 of 8)

NOTE: For more information on tropospheric scatter, LOS, and satellite stations, see MIL-HDBK-417, MIL-HDBK-416, and MIL-HDBK-412, respectively.

1. Panoramic profile:

a. Establish true north-south line; describe method: ____________________

____

____

____

____

____

____

____

____

b. Locate transit at proposed antenna location; describe and show location on sketch (add sheets if required):

____

____

____

____

____

____

____

____

c. Ground elevation at antenna location: __________ft (__________m)

d. Height of transit above ground: __________in. (__________cm)

APPENDIX F, ANNEX B
Tropospheric Scatter - LOS - Satellite Stations
(Page 2 of 8)

e. Record vertical angle to obstructions or to the horizon at increments of 5° (maximum) for full 360°, where south = 180°, east = 90°.

Azimuth	Elevation	Azimuth	Elevation

(Reproduce table as needed.)

APPENDIX F, ANNEX B
Tropospheric Scatter - LOS - Satellite Stations
(Page 3 of 8)

2. New antenna layout:

Sketch antenna layout, indicating location, azimuth, type, size, height above ground, frequency of operation, and transmitter power.

3. Specific link horizon profile (record vertical angles for 10 ° each side of link azimuth or as specified by the project engineer):

Link A		Link B		Link C	
Azimuth	Elevation	Azimuth	Elevation	Azimuth	Elevation

(Reproduce table as needed.)

APPENDIX F, ANNEX B
Tropospheric Scatter - LOS - Satellite Stations
(Page 4 of 8)

4. Link path profile:

a. Link designation/terminal:

(1) Path distance: ________mi (________km)

(2) Azimuth: ________________________________

(3) Obstructions noted:

Number: ________________________________

Distance along path: ________mi (________km)

Description: ________________________________
(Attach path profile plot.)

b. Link designation/terminal:

(1) Path distance: ________mi (________km)

(2) Azimuth: ________________________________

(3) Obstructions noted:

Number: ________________________________

Distance along path: ________mi (________km)

Description: ________________________________
(Attach path profile plot.)

c. For additional links, add sheets as required.

5. Obstacles between the antenna and the beginning of the antenna far field:

a. Link designation/terminal: ________________________________

(1) Distance to beginning of far field: ________ft (________m)

(2) Sketch terrain and potential obstacles:

APPENDIX F, ANNEX B
Tropospheric Scatter - LOS - Satellite Stations
(Page 5 of 8)

b. Link designation/terminal: ______________________________

(1) Distance to beginning of far field: ________ft (________m)

(2) Sketch terrain and potential obstacles:

c. For additional links, add sheets as required.

6. Link path loss measurements (if required):

a. Link designation/terminal: ______________________________

(1) Antenna location and height: ______________________________

____

(2) Description of test equipment used: ______________________________

____

____

____

(3) Calibration data: ______________________________

____

____

(2) Measurement data: ______________________________

____

____

APPENDIX F, ANNEX B
Tropospheric Scatter - LOS - Satellite Stations
(Page 6 of 8)

Date/ Time	Weather	Visibility	Wind (dir., speed)	Temp.	Azimuth	Path loss (dB)

b. For additional links, add sheets as required.

7. ICF cable route: Complete annex D worksheet.

8. Radio interference (see MIL-HDBK-417 for a description of the various types of interference that need investigation):

Type of interference	Azimuth to interference	Severity of interference

APPENDIX F, ANNEX B
Tropospheric Scatter - LOS - Satellite Stations
(Page 7 of 8)

9. Existing towers:

a. Sketch tower layout of site, including guy wires and feed runs.

b. For each tower, complete the following entries:

WARNING

Information concerning frequencies for certain sites may be classified. Consult the project classification guide or the security officer of the operating command to determine whether the table below requires classification when filled in.

Tower designation: ______________________________

Antenna type	Height above ground	Size of face	Location on tower	Azimuth	Freq. and polarization*	Xmit power	Feedline type
Example: Dish	60 ft	3.1 m diameter	North face	15°	4495V	5W	rectangular waveguide

* Indicate polarization with an 'H' (for horizontal) or 'V' (for vertical) after the frequency.

(Reproduce table as needed.)

APPENDIX F, ANNEX B
Tropospheric Scatter - LOS - Satellite Stations
(Page 8 of 8)

10. Information on miscellaneous existing facilities:

a. Condition of waveguide (number of flex sections, corrosion, etc.): ______________________

____

____

b. Dehydrator capacity: ______________________________

c. Radio and multiplex description: ______________________

____

d. Attach a sketch of the floor plan of existing buildings and associated equipment.

11. Sources of information:

If existing documentation, identify each document and items covered: ______________________

____

____

____

If on-site interview, identify persons and items discussed: ______________________

____

____

____

If direct observation, identify the observer and areas observed: ______________________

____

____

____

12. Remarks: ______________________________

____

____

____

APPENDIX F, ANNEX C
HF Transmitter - Receiver Stations
(Page 1 of 6)

NOTE: For more information on High Frequency Radio Communications, see MIL-HDBK-413.

1. Panoramic profile:

a. Establish true north-south line; describe method: ______________________________

____

____

____

____

____

____

____

____

b. Locate transit at proposed antenna location; describe and show location on sketch (add sheets if required):

____

____

____

____

____

____

____

____

c. Ground elevation at antenna location: __________ft (__________m)

d. Height of transit above ground: __________in. (__________cm)

APPENDIX F, ANNEX C
HF Transmitter - Receiver Stations
(Page 2 of 6)

e. Record vertical angle to obstructions or to the horizon at increments of 5° (maximum) for full 360°, where south = 180°, east = 90°.

Azimuth	Elevation	Azimuth	Elevation

(Reproduce table as needed.)

APPENDIX F, ANNEX C
HF Transmitter - Receiver Stations
(Page 3 of 6)

2. Antenna field.

Attach detailed drawing of proposed antenna farm showing size, orientation, spacing, feedline path, guy wires, and terminal buildings of existing or proposed HF antenna systems.

3. Interconnecting facilities:

a. Cable: Complete annex D worksheet.

b. LOS radio: Complete annex B worksheet.

4. Obstructions:

Are there any manmade or natural objects that could interfere with the antenna radiation pattern? If so, attach a sketch showing azimuth and elevation of each object.

5. Site isolation data:

a. Transmitter or receiver site to:

	Distance	Azimuth keyed to site drawing
(1) Airfield:	______mi (______km)	______
(2) Industrial area(s):	______mi (______km)	______
(3) Inhabited area(s):	______mi (______km)	______
(4) Major highway(s):	______mi (______km)	______
(5) Air search radar:	______mi (______km)	______

b. Receiver site to:

	Distance	Azimuth keyed to site drawing
(1) Transmitter site:	______mi (______km)	______
(2) Other HF transmitters:		
(a) ______	______mi (______km)	______
(b) ______	______mi (______km)	______
(c) ______	______mi (______km)	______
(d) ______	______mi (______km)	______

APPENDIX F, ANNEX C
HF Transmitter - Receiver Stations
(Page 4 of 6)

(3) Navigational aid(s): ________mi (________km) ____________________

(4) Overhead power line(s): ________mi (________km) ____________________

(5) Hospital(s): ________mi (________km) ____________________

6. Radio interference (see MIL-HDBK-417 for a description of the various types of interference that need investigation):

Type of interference	Azimuth to interference	Severity of interference

7. Existing towers:

a. Sketch tower layout of site, including guy wires and feed runs.

APPENDIX F, ANNEX C
HF Transmitter - Receiver Stations
(Page 5 of 6)

b. For each tower, complete the following entries:

WARNING
Information concerning frequencies for certain sites may be classified. Consult the project classification guide or the security officer of the operating command to determine whether the table below requires classification when filled in.

(1) Tower designation: ______________________________

Antenna type	Size	Location on tower	Orientation azimuth	Freq. of oper.	Xmit power	Feedline type

(Reproduce table as needed.)

9. Sources of information:

If existing documentation, identify each document and items covered: ______________________________

____

____

____

If on-site interview, identify persons and items discussed: ______________________________

____

____

____

APPENDIX F, ANNEX C
HF Transmitter - Receiver Stations
(Page 6 of 6)

If direct observation, identify the observer and areas observed: ____________________

____

____

____

10. Remarks: ____________________

____

____

____

APPENDIX F, ANNEX D
ICF Cable
(Page 1 of 5)

1. Cable-laying technique: __________Buried __________Aerial

2. Proposed route diagram:

Using a small-scale map, sketch the proposed cable route, indicating terminal locations, section lengths, cable-laying techniques, road-crossing techniques, and location of repeaters.

3. Route ownership:

Section of route	Ownership
____________________	____________________
____________________	____________________
____________________	____________________

4. Rights-of-way:

a. Controlling agency: ______________________________

b. Type of document or drawing required: ______________________________

____

5. Construction permits:

a. Issuing agency: ______________________________

b. Type of document or drawing required: ______________________________

____

6. Conduit:

Fill in each item below separately or give a narrative description on a separate page. Include a drawing that shows the routing of existing runs and proposed runs. Cross reference each item below to the drawing or include the information directly on the drawing. If appropriate, make copies of this worksheet and complete separate copies for separate runs.

a. Describe the routing of existing conduit runs: ______________________________

____

____

b. What type of conduit is used? Give diameter and location:

Thin wall: ______________________________

____

Plastic: ______________________________

____

Flexible: ______________________________

____

Rigid: ______________________________

____

Other: ______________________________

____

c. Which conduit runs have been grounded? ______________________________

____

____

____

Are separate ground wires used, or is the conduit itself used as a ground conductor? ______________

____

____

Where separate ground wires are used, give the following information: type (e.g., solid bare copper wire or green-insulated copper wire), size of the wire, whether or not the conductor is run internal to the conduit or clamped externally to it, whether the ground wire is bonded to the conduit, and the intervals at which this bonding takes place:

____

____

____

Describe any electrical discontinuities in the conduit: ______________________________

d. What conductors are currently housed in this run? ______________________________

Identify any conduit runs that enclose both signal conductors and power conductors. If such runs exist, give the size and voltage of the power conductors:

____

e. Identify any signal conduit that runs parallel to power conductors. Give the length of these parallel runs, the distances separating the signal conduit from the power conductors, and the size of power conductors and the voltages they carry:

____

f. Within existing signal conduit, how much space is available for additional conductors? ______________________________

g. Give the location of and distances between breakout boxes: ______________________________

APPENDIX F, ANNEX D
ICF Cable
(Page 4 of 5)

h. Give the location and description of points where signal conduit enters buildings: ____________

i. Describe the use and routing of proposed new conductors in existing conduit: ____________

j. Describe the routing of proposed new conduit runs: ____________

Describe any restrictions on routing new conduit runs: ____________

7. Sources of information:

If existing documentation, identify each document and items covered: ____________

APPENDIX F, ANNEX D
ICF Cable
(Page 5 of 5)

If on-site interview, identify persons and items discussed: ______

______

______

______

If direct observation, identify the observer and areas observed: ______

______

______

______

8. Remarks: ______

______

______

______

APPENDIX F, ANNEX E
Submarine Cable Terminals
(Page 1 of 2)

1. Location of cable terminals (UTMG): ______________________________

______________ Latitude ______________ Longitude

2. Cable landing diagram:

Attach small-scale coastal map indicating the landing sites.

3. Landing site characteristics:

a. Beach slope: ______________________________
(sharp, medium, shallow)

b. Beach topography: ______________________________
(sand, rock, coral)

c. Ice formation: ______________________________
(depth of ice scour)

4. Offshore boat traffic: ______________________________

____

____
(light pleasure craft, heavy commercial fishing, etc.)

5. Ocean currents:

Attach hydrographic charts of area ocean currents and winter ice conditions.

6. Offshore and land profiles:

Attach profile drawings of proposed offshore and land cable routes.

7. Beach profile:

Attach small-scale drawing showing shore approach from both water and land, indicating water and land obstructions and high- and low-tide limits.

8. Interconnecting communications:

a. If LOS radio, complete annex B worksheets.

b. If cable, complete annex D worksheets.

APPENDIX F, ANNEX E
Submarine Cable Terminals
(Page 2 of 2)

9. Sources of information:

If existing documentation, identify each document and items covered: ______________________

____

____

____

If on-site interview, identify persons and items discussed: ______________________

____

____

____

If direct observation, identify the observer and areas observed: ______________________

____

____

____

10. Remarks: ____

____

____

____

APPENDIX F, ANNEX F
Fiber Optic Communications
(Page 1 of 2)

NOTE: For more information on fiber optic communications systems, see MIL-HDBK-415.

1. Link identification: ______________________________

2. Terminal locations: ______________________________

____

3. Link requirements:

a. Length: __________mi (__________km)

b. Distance between repeaters: __________mi (__________km)

c. Power margin: __________dB

d. Receiver dynamic range: __________dB

e. Data rate or bandwidth:

(1) Digital link:

(a) Data rate: __________Mbps

(b) Coding type: ____________________
(e.g., RZ, NRZ, diphase)

(c) Optical line rate: ______________Mbps

(d) Bit error ratio (BER): ______________

(e) Allowable rise time: ______________ns

(f) Allowable jitter: ______________ns

(2) Analog link:

(a) Bandwidth: ______________MHz

(b) Signal-to-noise ratio (SNR): ______________dB

4. Equipment-side interface requirements: ______________________________

____
(data rates, data type (e.g., RS-232, Bell T-1))

APPENDIX F, ANNEX F
Fiber Optic Communications
(Page 2 of 2)

5. Proposed route information (use annex D worksheets).

6. Sources of information:

If existing documentation, identify each document and items covered: ______

______

______

______

If on-site interview, identify persons and items discussed: ______

______

______

______

If direct observation, identify the observer and areas observed: ______

______

______

______

7. Remarks: ______

______

______

______

APPENDIX F, ANNEX G
Switching Centers
(Page 1 of 3)

1. Switch type: ____________________

2. Line sizing (number of terminations):

   a. Off-premises extensions (extended loops/remotes): ____________________

   b. 2-wire loop subscribers: ____________________

   c. 4-wire loop subscribers: ____________________

   d. Total equipped lines (number in service): ____________________

   e. Total wired lines (switch capacity): ____________________

3. Digital trunk sizing:

   a. Number of digital trunk groups: ____________________

   b. Number of single digital trunk terminations: ____________________

Distant switch	Quantity

4. Analog trunk sizing:

   a. Number of 2-wire (loop dial) trunk terminations: ____________________

Distant end	Direction (2-way/1-way)	Quantity

APPENDIX F, ANNEX G
Switching Centers
(Page 2 of 3)

b. Number of 4-wire trunk terminations: ____________________

Distant end	Direction (2-way/1-way)	Quantity
________	________	________
________	________	________
________	________	________

5. Switch timing: ____________________

6. Number of outside plant cable pairs to be terminated on main distribution frame (MDF): __________

7. Dial dictation ports required: ____________________

8. Failure transfer circuits:

a. Number of circuits required: ____________________

b. Distant terminating switches:

Location(s)	Quantity
________	________
________	________
________	________

9. Conference circuits required: ____________________

Number of conferees in circuit:

(1)________ (2)________ (3)________

(4)________ (5)________ (6)________

10. Emergency action console (EAC) subsystem:

a. Number of consoles required: ____________________

b. Special features: ____________________

11. Interconnect facility:

a. Cable: Complete annex D worksheets.

b. LOS radio: Complete annex B worksheets.

APPENDIX F, ANNEX G
Switching Centers
(Page 3 of 3)

12. Sources of information:

If existing documentation, identify each document and items covered: ______

If on-site interview, identify persons and items discussed: ______

If direct observation, identify the observer and areas observed: ______

13. Remarks: ______

APPENDIX F, ANNEX H
Local Area Networks
(Page 1 of 4)

1. Node types:

Device	No. of units	Brand names	Model number	Location of units	Data rates (kbps)
a. Subscriber terminals: (dumb)	______	______	______	______	______
b. Subscriber terminals: (smart)	______	______	______	______	______
c. Micro-computers:	______	______	______	______	______
d. Mini-computers:	______	______	______	______	______
e. Main-frame computers:	______	______	______	______	______
f. Video:	______	______	______	______	______
g. Facsimile:	______	______	______	______	______
h. Remote telemetry:	______	______	______	______	______
i. Slave printers:	______	______	______	______	______
j. Stand-alone printers:	______	______	______	______	______
k. Graphic plotters:	______	______	______	______	______
l. Other: ______ (specify)	______	______	______	______	______

2. Does a requirement exist for links between hosts? ______Yes ______No

If yes, for what purpose? ______________________________

3. Network:

a. Topology: ______________________________
(bus, ring, star, combination)

b. Type: ______Baseband ______Broadband

c. If baseband, specify line driver characteristics: ______________________________

____

APPENDIX F, ANNEX H
Local Area Networks
(Page 2 of 4)

d. If broadband, specify:

(1) Number of separate carrier channels: ____________________

(2) Full duplex: ________Yes ________No

(3) Channel data rates:

(a) ____________kbps

(b) ____________kbps

(c) ____________kbps

(d) ____________kbps

(4) Modem characteristics: ____________________

____

4. Transmission medium: ____________________
(twisted pair, coaxial, fiber optic)

5. Data repeaters or line amplifiers required? ________Yes ________No

If yes, describe type and give distance between repeaters or line amplifiers: ____________________

____

____

____

____

____

6. Areas of consideration in performing site surveys inside buildings:

a. Wall construction: ____________________
(brick, cinder block, plaster board, etc.)

b. Ceiling construction: ____________________
(plaster, acoustical tile, etc.)

c. Does riser have space to run cable? ________Yes ________No

APPENDIX F, ANNEX H
Local Area Networks
(Page 3 of 4)

d. Where are drop outlets to be located? ____________________

____

____

____

____

Are they flush with the wall? __________Yes __________No

e. Are there communications closets on each floor? __________Yes __________No

If not, look for alternate routes for cable.

7. Areas of consideration in performing site surveys outside buildings:

a. Is there space to run cables on telephone or power poles? __________Yes __________No

b. Can communications pedestals be used on ground or poles? __________Yes __________No

c. Can aerial cables be attached to buildings? __________Yes __________No

8. Overall network diagram:

Sketch detailed diagram of LAN showing types of nodes and cable- or wire-run distances.

9. Cable- or wire-run detail (use annex D worksheet).

APPENDIX F, ANNEX H
Local Area Networks
(Page 4 of 4)

10. Sources of information:

If existing documentation, identify each document and items covered: ______________________

____

____

____

If on-site interview, identify persons and items discussed: ______________________

____

____

____

If direct observation, identify the observer and areas observed: ______________________

____

____

____

11. Remarks: ____

____

____

____

APPENDIX G. ACRONYMS AND ABBREVIATIONS

The acronyms and abbreviations indicated with a star have been extracted from FED-STD-1037. They have been included in this appendix for the convenience of the user. For complete definitions, see FED-STD-1037.

ac	*	alternating current
AFM		Air Force Manual
AM	*	amplitude modulation
amps		amperes
AUTODIN	*	Automatic Digital Network
AUTOVON	*	Automatic Voice Network
avg		average
BER	*	bit error ratio
bps	*	bits per second
Btu		British thermal units
cemf		counter electromotive force
CFR		Code of Federal Regulations
ckt		circuit
cm		centimeter
CONUS	*	Continental United States
dB	*	decibel
dc	*	direct current
DCA	*	Defense Communications Agency
DCS	*	Defense Communications System
DoD	*	Department of Defense
DoDISS		DoD Index of Specifications and Standards
EAC		emergency action console
ECAC		Electromagnetic Compatibility Analysis Center
EMC	*	electromagnetic compatibility
EMI	*	electromagnetic interference
EMP	*	electromagnetic pulse
ETC		earth terminal complex
FM	*	Field Manual; frequency modulation
ft		feet
GHz	*	gigahertz
gal		gallon
gpm		gallons per minute
HEMP	*	high-altitude electromagnetic pulse
HF	*	high frequency
Hz	*	hertz
ICF		interconnect communications facility
IF	*	intermediate frequency

APPENDIX G. ACRONYMS AND ABBREVIATIONS

in.		inch
K		earth radius curvature constant
kVA	*	kilovolt-ampere
kW		kilowatt
kWh		kilowatt-hour
kbps	*	kilobits per second
L		liter
LAN	*	local area network
LF	*	low frequency
LOS	*	line of sight
Lpm		liters per minute
m		meter
Mbps	*	megabits per second
MDF	*	main distribution frame
MHz	*	megahertz
mi		mile
MOV		metal oxide varistor
NEC	*	National Electrical Code
NRZ	*	non-return-to-zero
ns	*	nanosecond
OSHA		Occupational Safety and Health Administration
PBX	*	private branch exchange
Pa		pascal
PF	*	power factor
POL		petroleum, oil, and lubricants
psi		pound-force per square inch
pwr		power
rf	*	radio frequency
RFI	*	radio frequency interference
rms	*	root-mean-square
RZ	*	return-to-zero
SNR	*	signal-to-noise ratio
TCF	*	technical control facility
UPS	*	uninterruptible power supply
UHF	*	ultra high frequency
UTMG		Universal Tranverse Mercator Grid
V	*	volt
VA	*	volt-ampere
Vac	*	volts alternating current
Vdc	*	volts direct current
VHF	*	very high frequency
wpm	*	words per minute

Custodians:
Army — SC
Navy — EC
Air Force — 90

Review activities:
Army — CR
Navy — OM
Air Force —
DCA — DC
JTC3A — JT
NSA — NS

User activities:
Army —
Navy —
Air Force —

Preparing Activity:
Army — SC
(Project SLHC-4200)

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