UFC 4-141-10
22 September 2022

# UNIFIED FACILITIES CRITERIA (UFC)

# AIRFIELD OPERATIONS SUPPORT FACILITIES

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# UNIFIED FACILITIES CRITERIA (UFC)

# AIRFIELD OPERATIONS SUPPORT FACILITIES



Indicate the preparing activity beside the Service responsible for preparing the document.

U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING SYSTEMS COMMAND (Preparing Activity)

AIR FORCE CIVIL ENGINEER CENTER

Record of Changes (changes are indicated by **1**\ ... /**1**/)

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**This UFC supersedes UFC 4-141-10N, dated January 2004.**

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# FOREWORD

The Unified Facilities Criteria (UFC) system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with USD (AT&L) Memorandum dated 29 May 2002. UFC will be used for all DoD projects and work for other customers where appropriate. All construction outside of the United States is also governed by Status of Forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA). Therefore, the acquisition team must ensure compliance with the most stringent of the UFC, the SOFA, the HNFA, and the BIA, as applicable.

UFC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Systems Command (NAVFAC S), and Air Force Civil Engineer Center (AFCEC) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content of UFC is the responsibility of the cognizant DoD working group. Recommended changes with supporting rationale may be sent to the respective DoD working group by submitting a Criteria Change Request (CCR) via the Internet site listed below.

UFC are effective upon issuance and are distributed only in electronic media from the following source:

- Whole Building Design Guide web site http://www.wbdg.org/ffc/dod.

Refer to UFC 1-200-01, *DoD Building Code*, for implementation of new issuances on projects.

**AUTHORIZED BY:**

PETE G. PEREZ, P.E., SES
Chief, Engineering and Construction
U.S. Army Corps of Engineers

R. DAVID CURFMAN, P.E., SES
Chief Engineer
Naval Facilities Engineering Systems Command

DAVID H. DENTINO, SES
Deputy Director of Civil Engineers
DCS/Logistics, Engineering &
Force Protection (HAF/A4C)
HQ United States Air Force

MICHAEL McANDREW, SES
Deputy Assistant Secretary of Defense
(Construction)
Office of the Secretary of Defense

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# CHAPTER 1 INTRODUCTION

## 1-1 BACKGROUND.

This Unified Facilities Criteria (UFC), UFC 4-141-10, *Airfield Operations Support Facilities* provides requirements for evaluating, planning, programming, and designing Airfield Operations Support Facilities. The requirements contained in this UFC apply to Army, Navy, and Air Force facilities unless specifically referenced to a single service. This UFC is not intended as a substitution for thorough review during design by individual Program Managers and Operations Staff in the appropriate service.

The desired goal of this UFC is to maintain consistency in Air Operations Support Facility requirements across the Army, Navy and Air Force. This UFC is not intended as an operational manual.

Each service has unique requirements to fulfill specific missions. This document highlights any key differences that impact the overall facility program, layout and design. Where one Service's criteria vary from the other Services' criteria, it is noted in the text.

## 1-2 INCORPORATES AND CANCELS.

UFC 4-141-10N, *Design: Aviation Operation and Support Facilities*, 16 January 2004.

## 1-3 PURPOSE AND SCOPE.

This UFC is organized with general requirements for several different categories of airfield operations support facilities included in separate chapters. Within each chapter, the planning and design requirements for one or more system are described, with differences between Service requirements identified.

## 1-4 APPLICABILITY.

The information in this UFC applies to the design of all new construction projects, to include additions, alterations, and renovation projects within the United States and its territories and possessions outside of the United States.

## 1-5 GENERAL BUILDING REQUIREMENTS.

Comply with UFC 1-200-01, *DoD Building Code*. UFC 1-200-01 provides applicability of model building codes and government unique criteria for typical design disciplines and building systems, as well as for accessibility, antiterrorism, security, high performance and sustainability requirements, and safety. Use this UFC in addition to UFC 1-200-01 and the UFCs and government criteria referenced therein.

### 1-5.1 Facility Requirements Document (FRD)

The airfield operations support facility manufacturer's FRD or equivalent document is an integral requirement of facility design that contains additional specific facilities requirements that must be considered and satisfied in addition to this UFC.

FRDs are typically authored by the system manufacturer and contain many specific details, are often quite voluminous and difficult to obtain. The FRD may have additional technical facility requirements, special maintenance procedures, systems, data or other items that may impact the airfield operations support facility design. This UFC is not a substitute for the FRD of the support facility.

## 1-6 CYBERSECURITY.

All control systems (including systems separate from an energy management control system) must be planned, designed, acquired, executed, and maintained in accordance with UFC 4-010-06, *Cybersecurity of Facility-Related Control Systems*, and as required by individual Service Implementation Policy.

Cybersecurity is implemented to mitigate vulnerabilities to all DoD real property facility related control systems to a level that is acceptable to the System Owner and Authorizing Official. UFC 4-010-06 provides requirements for integrating cybersecurity into the design and construction of control systems.

## 1-7 GLOSSARY.

APPENDIX B contains acronyms, abbreviations, and terms.

## 1-8 REFERENCES.

APPENDIX C contains a list of references used in this document. The publication date of the code or standard is not included in this document. Unless otherwise specified, the most recent edition of the referenced publication applies.

# CHAPTER 2 GENERAL PLANNING AND DESIGN CONSIDERATIONS

## 2-1 INTRODUCTION.

## 2-2 SERVICE CONTACT AGENCIES.

For additional information and guidance on the topics covered in this UFC, contact the following agencies within each Service. These agencies were instrumental in providing the contents of this UFC.

### 2-2.1 Army.

Fixed Base Division
Air Traffic Services Command (ATSCOM)
Ft Rucker, AL
Email: usarmy.rucker.forscom.mbx.afat-ats-cb@mail.mil

### 2-2.2 Navy.

a. Instrument Landing System and Shore Instrument Carrier Landing System Facilities

Naval Air Warfare Center Aircraft Division – Webster Outlying Field (NAWCAD WOLF)
17464 Webster Field Road, Building 8131
St. Inigoes, MD 20684
Email: shore_ls@us.navy.mil

b. Shore Based Airport Surveillance Radar (ASR), ATC Communications Facilities, and Automated Surface Observing System (ASOS)

Naval Information Warfare Center (NIWC) – Atlantic
ATC Engineering Division
P.O. Box 190022
North Charleston, SC 29419
Email: atcweb@navy.mil

c. TACAN & PAR Facilities

Naval Information Warfare Center (NIWC) – Pacific
Code 41110 Tactical Air Navigation Branch
53560 Hull Street
San Diego, CA 92152-5001
Email: tacan@navy.mil, NIWC_4110_TACAN_ISEA@us.navy.mil

### 2-2.3 Air Force.

ATCALS Maintenance Division
Air Force Flight Standards Agency
HQ AFFSA/XM
Oklahoma City, OK
Email: HQAFFSA.XM.ATCALS.1@us.af.mil

## 2-3 GENERAL PLANNING CONSIDERATIONS.

### 2-3.1 Key Planning Documents.

| | |
|---|---|
| UFC 2-000-05N | *Facility Planning for Navy and Marine Corps Shore Installations* |
| UFC 2-100-01 | *Installation Master Planning* |
| UFC 3-201-01 | *Civil Engineering* |
| UFC 3-260-01 | *Airfield and Heliport Planning and Design* |
| NAVFACINST 11010.45A | *Site Approval Request Process* |

### 2-3.2 Planning Process.

The planning process is used to define and consolidate requirements for a new facility and then select a site that meets those requirements while also fitting within site constraints. Each Service has their own defined process for site selection that must be followed for every facility project. The planning process ensure that the full range of factors that may influence site selection are considered before site approval is achieved.

Factors that must be considered include:

- Installation Master Plan
- Land Use Compatibility (AICUZ)
- Topography and Flood Protection
- Airfield Clearances
- Airspace Clearances
- Roadway Access
- Environmental Constraints
- Natural, Historic and Cultural Resources
- Future Development
- Explosive Safety Quantity-Distance Arcs

- Security
- Connections to other Facilities

All new construction must be evaluated for potential environmental impacts following the requirements of the National Environmental Policy Act (NEPA). See Service-specific guidance for implementation of this process.

Ensure the Lead Service Agencies are consulted early in the planning and programming process to explore all viable options and make the best possible site selection.

In most cases, the facilities described in this UFC must be sited in a particular location to properly function. However, site-specific conditions might require a non-standard installation. Where a non-standard installation is required and conflicts with the airfield clearances described in UFC 3-260-01, follow the Service-specific waiver processing procedures outlined in UFC 3-260-01, Appendix B, Section 1 during site selection and approval, before detailed design or construction has begun.

## 2-4 GENERAL DESIGN CONSIDERATIONS.

### 2-4.1 Key Design Documents.

These are a partial list of key design documents that contain additional requirements for the respective subjects. Requirements in this UFC related to those subjects are additive and intended to conservatively supplement these documents and references. See Section 1-4 for General Building Requirements.

| | |
|---|---|
| UFC 1-200-01 | *General Building Requirements* |
| UFC 2-000-05N | *Facility Planning Criteria for Navy/Marine Corps Shore Installations* |
| UFC 3-101-01 | *Architecture* |
| UFC 3-110-03 | *Roofing* |
| UFC 3-201-01 | *Civil Engineering* |
| UFC 3-220-01 | *Geotechnical Engineering* |
| UFC 3-250-01 | *Pavement Design for Roads and Parking Areas* |
| UFC 3-260-01 | *Airfield and Heliport Planning and Design* |
| UFC 3-260-04 | Airfield and Heliport Marking |
| UFC 3-301-01 | *Structural Engineering* |
| UFC 4-010-01 | *DoD Minimum Antiterrorism Standards for Buildings* |

| | |
|---|---|
| UFC 4-022-03 | *Security Fences and Gates* |
| UFC 3-401-01 | *Mechanical Engineering* |
| UFC 3-410-01 | *Heating, Ventilating and Air Conditioning Systems* |
| UFC 3-420-01 | *Plumbing Systems* |
| UFC 3-450-01 | *Noise and Vibration Control* |
| UFC 3-460-01 | *Design: Petroleum Fuel Facilities* |
| UFC 3-501-01 | *Electrical Engineering* |
| UFC 3-520-01 | *Interior Electrical Systems* |
| UFC 3-530-01 | *Design: Interior and Exterior Lighting and Controls* |
| UFC 3-535-01 | *Visual Air Navigation Facilities* |
| UFC 3-540-01 | *Engine-Driven Generator Systems for Prime and Standby Power Applications* |
| UFC 3-575-01 | *Lightning and Static Electricity Protection Systems* |
| UFC 3-580-01 | *Telecommunications Building Cabling Systems Planning and Design* |
| UFC 3-600-01 | *Fire Protection Engineering for Facilities* |
| UFC 4-133-01 | *Air Traffic Control and Air Operations Facilities* |
| TSEWG TP-19 | *Static Uninterruptible Power Supply (UPS)* |
| FAA AC 70/7460-1 | *Obstruction Marking and Lighting* |
| FAA AC 150/5220-23 | *Frangible Connections* |
| FAA AC 150/5320-5 | *Surface Drainage Design* |
| SDDCTEA Pamphlet 55-17 | *Traffic and Safety Engineering for Better Entry Control Facilities* |

### 2-4.2 Site Selection.

In addition to the following paragraphs, site facilities in accordance with UFC 3-260-01. For Navy and Marine Corps, also check UFC 2-000-05N for airfield safety clearances.

### 2-4.2.1 Siting Criteria/Land Requirements.

For each Airfield Operations Support Facility there are specific criteria that must be met to allow the device to function properly. These requirements are described in the chapters for each system. The optimum location of the device relative to the runway/taxiway or airport varies by the function of the device. There are tolerances to the ideal device siting location, which allow some flexibility to fit existing facilities.

### 2-4.2.2 Separation/Clearance.

In addition to the location of the facility and the land needed, there are specific separation and clearance standards for each device for it to function properly and provide a safe environment for aircraft operations. Each device has allowable height and separation distances for above-ground objects around the device so that the electronic or light signal is not impacted. The size, shape, mass and material nature of the object can impact the function of a device that transmits an electronic signal. For communications and surveillance antennas, including some NAVAID antennas, there is a critical area immediately around the device that must be kept clear of all above-ground objects. Once a NAVAID is installed, it is essential to maintain the separation and clearance standards as future construction is considered in the vicinity of the facility. A Notice of Proposed Construction or Alteration (FAA Form 7460-1) must be submitted to the FAA to allow an evaluation of the potential impact of any proposed construction in the vicinity of a NAVAID. Sometimes the nature of construction activity will by itself mean that the NAVAID must be temporarily turned off, to prevent a false signal from being transmitted.

### 2-4.2.3 Critical Areas.

Many NAVAIDs and ATC facilities have a defined critical area that must be protected to ensure adequate performance.

a. Geometry. Each critical area extends a certain distance out in all or select directions. It can be circular-, rectangular- or wedge-shaped. The dimensions may vary based on the aircraft and terminal operations the NAVAID and ATC facility is designed to serve and the precision of the device in use.

b. Grading. There are standards for grading the ground around each of the NAVAIDs. In general, grade the immediate area around the device relatively smooth, level and well drained.

c. Protection. Coordinate maintenance activities, such as mowing or the use of service vehicles, within the critical area with the tower and airfield management offices to prevent a degradation of the function of the NAVAID during Instrument Flight Rules (IFR) conditions when the operation of the NAVAID is critical. Proposed construction in the vicinity of any NAVAID must be reviewed and analyzed by the Lead Service Agency to determine any potential impacts to the function of the NAVAID. For off-airport NAVAIDs, installation of fencing or guardrails along the perimeter

of the critical area is needed to keep these areas clear. For certain systems, due to false reflective targets or poor accuracy, exercise care when a decision to fence around a critical area is made.

#### 2-4.2.4 Jet Blast/Exhaust.

Locate NAVAIDs, monitoring devices, and equipment shelters at least 600 feet (183 m) behind the source of jet blast to minimize the accumulation of exhaust deposits on antennas.

### 2-4.3 NAVAIDs as Obstacles.

Any object, including NAVAIDs, that are located near an active runway can present an increased risk to aircraft operations. In particular, UFC 3-260-01 recognizes the need to limit NAVAIDs except those required to be in a certain location to perform their function and may fall within the Primary Surface or penetrate Imaginary Surfaces. Any NAVAID object that remains inside the Primary Surface must be supported by frangible structures that minimize damage to any aircraft that might strike the object.

#### 2-4.3.1 Permissible Deviations (Army and Air Force) and Standard Exceptions (Navy and Marine Corps).

While it is desirable not to have any objects in areas that could be a hazard to aircraft, some properly sited NAVAIDs have been classified as being Permissible Deviations (Army and Air Force per UFC 3-260-01, Appendix B, Section 13) or Standard Exceptions (Navy and Marine Corps per UFC 3-260-01, Chapter 2). In other words, the NAVAID location is critical for its proper functioning and the safety benefit derived from the operation of the NAVAID outweighs the potential risk of an aircraft striking the NAVAID. A permissible deviation or standard exception determination allows NAVAIDs to be in the Primary Surface. However, the power and control equipment and shelters associated with certain NAVAIDs are not considered to be a permissible deviation or standard exception in regard to the Primary Surface, unless operational requirements require them to be near the NAVAID.

#### 2-4.3.2 Frangibility.

NAVAID objects located within operational areas on the airport are generally mounted with frangible couplings, with the point of frangibility no higher than 3 inches (75 mm) above the ground on the mounting legs, which are designed to break away upon impact. This reduces the potential damage to an aircraft that inadvertently leaves the paved surfaces. FAA AC 150/5220-23 provides guidance on frangible connections to meet frangibility requirements.

#### 2-4.3.3 Non-Standard Installations.

Any NAVAID or associated equipment that remains inside the Primary Surface and is not a permissible deviation or standard exception and does not meet frangibility

requirements is a non-standard installation. The NAVAID must be removed from the Primary Surface if practicable.

#### 2-4.3.4 Marking and Lighting.

NAVAIDs that penetrate the Imaginary Surfaces defined in UFC 3-260-01 are marked with international orange and white paint and lights, with red obstruction lights placed on the highest point. This makes the NAVAID and other ATC Facilities more visible to the pilot. See UFC 3-260-04 for marking requirements. See UFC 3-535-01 for obstruction lighting requirements.

### 2-4.4 Site Considerations.

#### 2-4.4.1 Site Suitability.

Basic considerations for site selection include terrain characteristics and meteorological conditions. Locate facilities requiring technical adequacy for radiation, reception, visibility, etc., following the requirements established by the governing agency or command responsible for the project. Ensure site selection considerations are fully understood and incorporated into the design. Site considerations for electronic facilities are generally contained in facility-specific FAA Orders or FRDs referenced in the following chapters. Ensure new systems do not encroach on Compass Calibration Pads. See UFC 3-260-01, Chapter 6 for specific requirements.

#### 2-4.4.2 Separation of Structures.

Comply with UFC 3-600-01.

#### 2-4.4.3 Access and Parking.

Provide paved access drives and parking lots for attended facilities. Access drives and parking facilities for unattended facilities may be unpaved except where access to the facility is directly from runways and taxiways. In these cases, pave minimum 300 feet (100 m) prior to connecting to an airfield operations surface (runway, taxiway, apron) to avoid the scattering of debris onto the operational surfaces. At facilities adjacent to runways and taxiways, provide parking space off the operational surface for a maintenance vehicle. Locate the parking space to avoid interference with the operation of any facilities in the area (e.g., provide adequate wingtip clearances). Ensure roadway and vehicle parking surfaces within the airfield operations area are flush with the surrounding ground surface. See UFC 3-250-01 for roadway design procedures. Grade unpaved access roads and parking areas to rapidly drain surface water and constructed with materials that remain stable to support maintenance vehicles in all local environmental conditions.

##### 2-4.4.3.1 Parking.

The number of parking stalls required at each facility varies dependent upon the function, location, and size of the user command. Consider double work shifts and shift

changes when determining the required number of parking stalls. Criteria for establishing the required number of parking stalls based on the type of facility and size of the work force are provided in SDDCTEA Pamphlet 55-17. In addition to requirements established in the reference document, conform to the following restrictions:

### 2-4.4.4 Access for Fire Department Vehicles.

Consult local authorities having jurisdiction for criteria regarding access to the area and clearance around the buildings for fire apparatus maneuvering. The equipment expected to respond to an emergency will control these decisions. See National Fire Protection Association (NFPA) 1141, Fire Protection in Planned Building Groups.

### 2-4.4.5 Site Drainage.

Provide drainage design in accordance with UFC 3-201-01. Metallic pipe and reinforced concrete pipe are inappropriate at some sites. Establish requirements for use of metallic pipe and reinforced concrete pipe early in facility planning. Consider drainage swales with minimal velocities to avoid erosion. See also FAA AC 150/5320-5 for surface drainage on airfields.

### 2-4.4.6 Protection of Fixed Objects.

In areas where frangibility is not a concern, provide barriers or bollards to protect non-frangible fixed objects (electrical transformers, generators, fuel tanks, fire hydrants, etc.) outside the primary surface from damage due to vehicles and moving equipment.

### 2-4.4.7 Airfield Safety.

Consider safety clearances listed in UFC 3-260-01 when siting facilities in or near aviation operational areas. For Navy and Marine Corps, also check UFC 2-000-05N for airfield safety clearances. Fabricate objects located within the Primary Surface for low impact resistance in accordance with FAA AC 150/5220-23. Provide obstruction marking or lighting for facilities located in or near aviation operational areas in accordance with UFC 3-260-04 and UFC 3-535-01.

## 2-4.5 Architectural Requirements.

Comply with requirements of UFC 3-101-01. Place design emphasis on fire resistance, minimal maintenance and repair cost, and ease of facility expansion or modification. Electronic communications equipment housed in the building varies with the mission of the installation. Design facility exterior in accordance with the base architectural compatibility guidance or local command architectural guidance.

### 2-4.5.1 ADA Requirements.

Provide barrier-free access to civilian workspaces and other spaces intended for public access. Design facilities to locate handicapped access spaces on first floor only unless

the size of the facility's administration and other accessible areas requires a second floor. Areas hazardous to handicapped persons need not be accessible. Comply with current criteria in Uniform Federal Accessibility Standards (UFAS). Refer to UFC 3-101-01.

### 2-4.6 Structural Requirements.

Design in accordance with UFC 3-301-01. Base an economical structural system on facility size, projected load requirements, quality of local available materials, local labor and construction materials, and local wind, snow, seismic, geologic, and permafrost conditions. Design structural systems to support roof-mounted and/or suspended loads, when required.

### 2-4.7 Construction Materials.

Design attended facility buildings using styles and materials as approved by the ordering authority. Unless otherwise directed, design unattended facility buildings using concrete, concrete masonry, pre-engineered metal, or premanufactured metal or fiberglass-reinforced plastic. Use construction methods that provide maximum overall economy consistent with functional and aesthetic requirements, reasonable comfort, and sound architectural and engineering practices. Select materials, equipment, and methods to result in low costs consistent with economic maintenance for the required use and life expectancy of the facility. Refer to UFC 1-200-01.

#### 2-4.7.1.1 Reflective Surfaces.

To prevent mirrorlike reflections from building surfaces to aircraft in flight, provide roofs and other external surfaces with a specular reflectance compatible with the location of the building on the airfield. If the building is located such that glare may be an operational hazard, provide the critical surfaces of that building with a light reflectance of not more than 10, measured at an angle of 85 degrees in accordance with American Society for Testing and Materials (ASTM) D 523, Standard Test Method for Specular Gloss.

#### 2-4.7.2 Floors and Foundations.

Construct antenna foundations, equipment pads and building floors with reinforced concrete on a compacted subbase or subgrade in accordance with UFC 1-200-01, UFC 3-220-01, and UFC 3-301-01. Site-specific design is required for all foundations and floors, considering the local soils, climate and environmental loads.

Unless otherwise indicated in this UFC or in specific system FRDs, provide equipment pads for prefabricated or modular shelters minimum 12-inches larger than the supported equipment on all sides.

For foundations on airfields, construct foundations or equipment pads 2 inches (50 mm) +/- 1 inch (25 mm) above the surrounding grade. When the foundation is surrounded by

airfield pavement or shoulder pavement, construct the foundation flush with surrounding pavement.

### 2-4.7.3 Roofing.

Provide roof system and insulation to meet the requirements of UFC 3-110-03. Determine thermal resistance of roof insulation by design criteria and life cycle costs.

## 2-4.8 Mechanical Requirements.

Comply with the requirements of UFC 3-401-01.

### 2-4.8.1 Energy Conservation.

Design climate-controlled facilities for energy efficiency. Consider isolated ventilation or air conditioning systems for equipment with high heat loads or that require more critical temperature or humidity control than would otherwise be required for the remainder of the occupancy.

### 2-4.8.2 Equipment Selection.

Select adequately sized air conditioning equipment for personnel comfort applications to remove the sensible and latent heat loads generated within these areas. Computer rooms and electrical equipment rooms produce predominantly sensible heat and require specially designed units. Ensure mechanical systems do not interfere with electronic equipment or radiated signals.

### 2-4.8.3 Heating and Air Conditioning.

Provide heating and air conditioning in accordance with UFC 3-401-01 and UFC 3-410-01. Provide duct smoke detectors and controls in accordance with UFC 3-600-01.

### 2-4.8.4 Plumbing.

Provide plumbing for facilities in accordance with UFC 3-420-01. Ensure that plumbing work not covered by UFC criteria meets the requirements of the National Plumbing Code Handbook.

#### 2-4.8.4.1 Water and Sanitation.

Unattended facilities are not normally provided with water and sanitation facilities (sink and toilets). However, provide water and sanitary facilities at unattended facilities where a significant amount of maintenance is anticipated, and sanitary facilities are not available in the vicinity. Consider the use of chemical toilets and bottled water.

### 2-4.8.5 Fire Protection.

Design fire protection systems in accordance with UFC 3-600-01.

### 2-4.8.6 Noise and Vibration Control.

Design mechanical systems and equipment to limit noise and vibration in accordance with UFC 3-450-01.

## 2-4.9 Electrical Systems.

Design electrical systems in accordance with UFC 3-501-01.

### 2-4.9.1 Lighting.

Design interior lighting in accordance with UFC 3-530-01.

### 2-4.9.2 Lightning Protection.

Design facilities for lightning protection. Refer to NFPA 78, *Lightning Protection Code*, and UFC 3-575-01 for minimum standards.

### 2-4.9.3 Emergency Electrical Power.

#### 2-4.9.3.1 Emergency Generator.

Provide emergency generators with electronic line monitoring equipment and automatic starting and switching capability. Design in accordance with UFC 3-540-01. When used in conjunction with an UPS, provide generator output at least 1.5 times the output rating of the UPS. Provide the following for emergency generators:

a. Unless otherwise noted, provide automatic starting and switching capable of supplying the rated load within 15 seconds of a power failure, except where Category II instrument operations are conducted.

b. During Category II instrument operations, a 1-second power transfer is required. This is normally accomplished by providing a remote start capability which permits operation of the systems on the generator during Category II weather conditions. Standby power is then subject only to switching time. The actual procedure must be locally coordinated.

c. An isolation switch to bypass the emergency generator during generator maintenance.

d. An automatic battery charger for maintenance of generator starting batteries.

e. An isolated mounting slab for the generator to reduce noise and vibration transmission.

f. Provide the following when an indoor emergency generator is required:

- A separate generator room with an independent ventilation system.

- An engine exhaust system connected to the exterior of the facility with an exterior muffler. Configure the exhaust system to prevent rainwater or condensation from entering the engine manifold.
- Adequate engine cooling by a radiator duct or externally mounted radiator.

g. Consider a premanufactured building to house an indoor generator. Consider an outdoor unit in mild climate conditions. Consider a below ground generator vault for units which must be sited within airfield clear zones or primary surfaces.

#### 2-4.9.3.2 Emergency Generator Fuel Storage.

Design fuel storage for generators in accordance with UFC 3-460-01 and UFC 3-540-01 as well as state and local regulations. Provide fuel storage capacity for 24 hours of continuous generator operation, unless otherwise noted in subsequent chapters. Provide double wall storage tanks and piping.

### 2-4.9.4 Uninterrupted Power Supply (UPS)

Provide an UPS in electronic facilities and air traffic control installations for critical technical loads and the specific requirements of the ordering authority. Install the UPS in accordance with UFC 3-501-01, UFC 3-520-01 and TSEWG TP-19.

## 2-4.10 Communications Systems.

Provide voice, data, and equipment control communications systems in accordance with UFC 3-580-01. Consider fiber optic systems in facilities requiring extensive internal communications systems for electronic cable protection.

Bury communication cables minimum 24 inches (610 mm) below ground. Install cables in concrete-encased conduit or duct bank beneath runways, taxiways, aprons, roadways and parking areas with regularly spaced manholes or handholes. Concrete-encase conduits where appropriate to protect critical communications systems from accidental damage during digging.

### 2-4.10.1 Cable Loop System.

For the benefit of redundancy and uninterrupted service, provide a cable loop system. FAA Order 6950.23 addresses control/monitor, digital data, voice/voice frequency and radar video/trigger signals.

## 2-4.11 Physical Security.

Comply with UFC 4-010-01. Where fences are required, comply with UFC 4-022-03.

## 2-4.12 Air Traffic Control Towers.

This UFC does not apply to Air Traffic Control Towers. See UFC 4-133-01.

## 2-5 STORMWATER MANAGEMENT.

Determine whether on-site stormwater management to address the added impervious surfacing associated with the concrete pads and gravel surfacing is required. If thresholds are exceeded, implement stormwater management strategies to meet the local, state, or federal guidelines for stormwater treatment. Typical strategies used include bioretention swales or cells, dispersing stormwater through existing or new vegetation, and infiltration facilities. See UFC 3-260-01, Chapter 2 for precautions and prohibitions regarding stormwater management facilities on or near airfields.

## 2-6 EROSION AND SEDIMENT CONTROL.

Install erosion control measures to prevent construction stormwater from leaving the project site and entering any adjacent storm system or critical areas. Measures must meet local, state, and federal guidelines. Typical erosion control measures that may be used include filter fabric fencing, silt sock fabric, and catch basin filter inserts.

## 2-7 FRANGIBILITY REQUIREMENTS.

Army and Air Force: Comply with frangibility requirements included in UFC 3-260-01, Appendix B, Section 13.

Navy and Marine Corps: Comply with frangibility requirements described in FAA AC 150/5220-23.

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# CHAPTER 3 AIR NAVIGATION AIDS

## 3-1 GENERAL INFORMATION.

Air Navigation Aid facilities are fixed ground station electronic equipment which transmit bearing, identification, and distance information to properly equipped aircraft. These facilities are unattended.

### 3-1.1 Function.

Air Navigation Aid facilities may consist of the following types of facilities.

**Table 3-1 Types of Air Navigation Aid Facilities**

| Designation | Type of Facility |
|---|---|
| VOR | VHF navigational facility, omnidirectional azimuth only |
| DME | UHF navigational facility, distance only |
| TACAN | UHF navigational facility, omnidirectional azimuth and distance |
| VOR/DME | Associated VOR and DME navigational facilities |
| VORTAC | Associated VOR and TACAN navigational facilities |

### 3-1.1.2 Very High Frequency (VHF) Omni-Directional Range (VOR) Systems.

The VOR facility is a VHF, fixed ground-based station which continuously transmits bearing, identification, and with proper equipment (DME), distance information to properly equipped aircraft. Figure 3-1 illustrates a typical VOR facility. See FAA AC 150/5300-13 and FAA Order 6820.10 for a detailed description of the features and different types of VOR facilities.

**Figure 3-1 VOR (VOR) Facility**

### 3-1.1.3 Distance Measuring Equipment (DME).

The DME provides pilots with a measurement of distance to the runway in nautical miles. The DME is a terminal area or en route navigation facility that provides the pilot with a direct readout indication of aircraft distance from the identified DME. It can be co-located with a VOR and/or a Localizer shelter. Figure 3-2 illustrates a typical DME antenna located adjacent to a Localizer Shelter.

**Figure 3-2 Omni-Directional Distance Measuring Equipment (DME) Antenna**

### 3-1.1.4 Tactical Air Navigation (TACAN) Systems.

The TACAN facility is an ultra-high frequency (UHF) ground-based station, developed by the military, which continuously transmits bearing, identification, and distance

information to properly equipped aircraft when interrogated. Figure 3-3 illustrates a typical TACAN facility.

**Figure 3-3 Typical TACAN Facility**

### 3-1.1.5 Very High Frequency (VHF) Omni-Directional Range/Tactical Air Navigation (VORTAC).

The VORTAC facility is a VHF/UHF fixed ground-based station which continuously transmits bearing, identification, and distance information to properly equipped aircraft when distance measuring equipment (DME) is installed. It combines a VOR and TACAN into one facility. Figure 3-4 illustrates a typical VORTAC.

**Figure 3-4 VORTAC Facility**

## 3-2 VERY HIGH FREQUENCY (VHF) OMNI-DIRECTIONAL RANGE (VOR) SYSTEMS.

### 3-2.1 Key Documents.

| | |
|---|---|
| UFC 3-260-01 | *Airfield and Heliport Planning and Design* |
| FAA AC 150/5300-13 | *Airport Design* |
| FAA Order 6780.5 | *DME Installation Standards Handbook Type FA-96-39 (Request from Lead Service Agency)* |
| FAA Order 6780.8 | *Distance Measuring Equipment (DME) Installation Standards Handbook Type FA-9783 (Request from Lead Service Agency)* |
| FAA Order 6820.10 | *VOR, VOR/DME, and VORTAC Siting Criteria* |
| AF T.O. 31Z3-822-2 | *Air Traffic Control Landing Systems (ATCALS) Site Requirements 404L* |

### 3-2.2 Siting.

If possible, locate the VOR in an area adjacent to the intersection of the primary runways. Locate the facility at the minimum distances from the centerline of runways and taxiways according to Table 3-2 and Figure 3-5. When the facility is located off the airfield, consider selecting a site with one or more flight path courses providing an approach to the primary runway. When sited outside these distances, include obstruction lighting if the VOR is within the primary surface or penetrates the imaginary surfaces defined in UFC 3-260-01. See UFC 3-260-01 and FAA Order 6820.10 for more details about siting considerations.

**Table 3-2 VOR Siting Dimensions**

| Item | | Legend in Figures | Requirement | | Remarks |
|---|---|---|---|---|---|
| No. | Description | | | | |
| 1 | Distance to Runway Centerline | A | Army | 250 ft (76 m) | Source: UFC 3-260-01, App. B, Section 13 |
| | | | Navy | 750 ft (229 m) | Source: UFC 4-141-10N (Jan 2004) |
| | | | Air Force | 500 ft (152 m) | Source: UFC 3-260-01, App. B, Section 13 |
| 2 | Distance to Taxiway Centerline | B | Army | 150 ft (46 m) | Source: UFC 3-260-01, App. B, Section 13 |
| | | | Navy | 250 ft (76 m) | Source: UFC 4-141-10N (Jan 2004) |
| | | | Air Force | 200 ft (61 m) | Source: UFC 3-260-01, App. B, Section 13 |

The area around the VOR must be clear and reasonably smooth. Per FAA Order 6820.10, all obstructions within 1,000 feet (305 m) of the antenna are to be removed except as noted below. See Figure 3-6 for airspace clearances surrounding the VOR.

- Trees and Forests. Trees close to the VOR antenna can cause severe scalloping. Single trees of moderate height (up to 30 feet (9 m)) may be tolerated beyond 500 feet (152 m), but no closer. Groups of trees are not allowed within a 1,000-ft (305 m) radius or subtend a vertical angle of more than 2 degrees.
- Wire Fences. Ordinary farm-type wire fences about 4-feet (1 m) high are not permitted within 200 feet (61 m) of the antenna; fences of the chain type 6 feet (1.8 m) or more in height are not permitted within 500 feet (152 m) of the antenna; beyond these distances wire fence is not permitted to extend more than 0.5 degrees above the horizontal, measured from the antenna.
- Power and Control Lines. Install power and control line extensions underground for a minimum distance of 600 feet (183 m) from the antenna. Overhead power and control lines may be installed beyond 600 feet (183 m) if they are essentially radial to the antenna for a minimum distance of 1,200 feet (366 m).
- Structures. Structures are not allowed within 1,000 feet (305 m) of the antenna, except for buildings such as the transmitter building at a mountain top site located on a slope below the ground level of the antenna so that they are not visible from the antenna.

#### 3-2.2.1 Army and Air Force.

When used as a terminal navigational aid, the VOR facility may be sited not less than 500 feet (152 m) from the centerline of any runway to the edge of the facilities, provided the elevation of the antenna does not exceed 50 feet (15 m) above the highest point of the adjacent runway centerline. For an on-base installation, the maximum angle of convergence between the final approach course and the runway centerline is 30 degrees. Align the final approach course to intersect the extended runway centerline 3,000 feet (914 m) outward from the runway threshold. When an operational advantage can be achieved, this point of intersect may be established at any point between the threshold and a point 5,200 feet (1,585 m) outward from the runway threshold. Also, where an operational advantage can be achieved, a final approach course which does not intersect the runway centerline or intersects at a point greater than 5,200 feet (1,585 m) outward from the runway threshold may be established, provided that such a course lies within 500 feet (152 m) laterally of the extended runway centerline at a point 3,000 feet (914 m) outward from the runway threshold.

### 3-2.3 Security.

VOR facilities are normally located within the airfield restricted area. This siting typically meets the minimum security measures for external security. When the facility is located

within a restricted area of a lower level of security or is located remote and outside of an established restricted area, provide additional measures to meet the minimum security requirements for the level of security assigned to the facility.

### 3-2.4 Facility Design Guidance.

Provide an equipment building with roof-mounted antenna. See Figures 3-7 and 3-8 for typical site plan and building layout. See Figure 3-9 for a typical building section. See service-specific guidance for allowable building size. Typical building size is 300 square feet (28 square meters) to house the electronic equipment, monitoring and test equipment, and mechanical equipment.

#### 3-2.4.1 Site Work.

Provide an access road to allow maintenance vehicles access to the VOR. Provide parking space for two maintenance vehicles. See Chapter 2, paragraph “Access and Parking” for roadway and parking area design requirements.

#### 3-2.4.2 Architectural Requirements.

Provide the following:

- Adequate space for equipment and equipment maintenance.
- Clear ceiling height of 10 feet (3 m).
- Work bench.

Do not provide a restroom.

Do not provide windows.

Consider the use of a premanufactured building.

#### 3-2.4.3 Structural Requirements.

Provide sufficient roof area to accommodate the VOR roof mounted antenna and counterpoise. Consider an extended roof overhang or an antenna tower to accommodate a large antenna counterpoise.

##### 3-2.4.3.1 Concrete Pad.

For a shelterized unit, provide a minimum 15’ x 20’ (5 m x 6 m) concrete pad, minimum 6” (150 m) thick with welded wire mesh, and minimum 10” (250 mm) thick at the edges tapering to 6” (150 mm) thick at 2’ (0.6 m) from all edges. In the 10” (250 mm) thick region, place reinforced steel bars (rebar) under the mesh at mid-depth. These requirements for thickness and reinforcement are for optimal soil conditions.

Size of concrete pad may be designed to be larger, as determined by the site-specific requirements.

### 3-2.5 Mechanical Requirements.

Provide HVAC system to maintain shelter temperature between 65° and 80° F (18° and 27°C). Provide humidity control to maintain humidity between 0 and 95%, with no condensation.

Air Force: See Environmental Control Unit requirements (e.g., allowable temperature and humidity ranges) in AF T.O. 31Z3-822-2, Chapter 3.

### 3-2.6 Electrical Power.

To avoid potential interference with radar transmissions, locate power, communications, and control cables underground within 1,000 feet (305 m) from the facility. Ensure electrical systems do not interfere with radar transmissions.

Provide 120/240V, 100A, single-phase, 60 HZ commercial power service to the VOR facility.

Air Force: See Commercial Power, Uninterruptible Power Supply, and Backup Power, in AF T.O. 31Z-822-2, Chapter 1. See Grounding, Bonding Shielding and Lightning Protection requirements in AF T.O. 31Z-822-2, Chapter 2.

#### 3-2.6.1 Emergency Electrical Power.

Provide an emergency generator with automatic starting and switching capability as described in Chapter 2. Provide emergency power to the entire facility.

#### 3-2.6.2 Grounding and Bonding.

Install two (2) ground rods, one on each 20’ (6 m) side of the concrete pad. Provide separate ground cables, one for the shelter and one for a direct path to ground from the antenna lightning arrestor.

### 3-2.7 Communications.

Provide 12-strand single mode fiber optic cable or 25 twisted pair communications line to provide required connectivity for data and telephone.

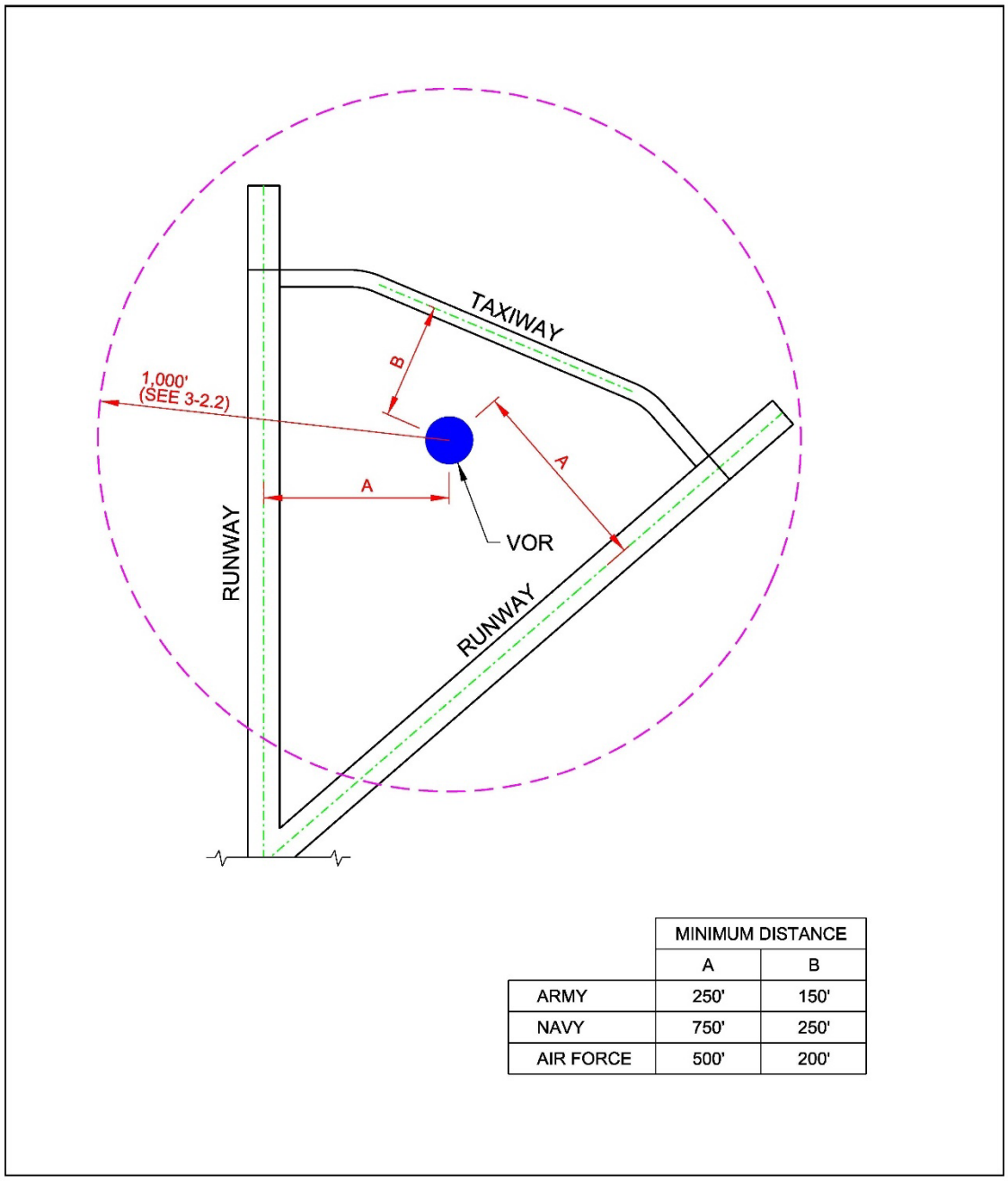
- Data connectivity from the VOR Shelter to Remote Unit located in the ATC Tower.
- Data connectivity from the VOR Shelter Fire Alarm to external monitoring system.
- Telephone line for distance support to troubleshoot system.

Air Force: See fiber optic cable and modem requirements in AF T.O. 31Z-822-2, Chapter 4.

### 3-2.8 Connection/Interrelation to other Facilities.

Connect a dedicated DSN-capable telephone connection through to the VOR to facilitate distant support, troubleshooting, and corrective maintenance due to the remote location. Connect the VOR to the ATC Tower via fiber optic cable for remote monitoring.

**Figure 3-5 VOR Siting**




| | MINIMUM DISTANCE | |
|---|---|---|
| | A | B |
| ARMY | 250' | 150' |
| NAVY | 750' | 250' |
| AIR FORCE | 500' | 200' |

**Figure 3-6 VOR Clearances**

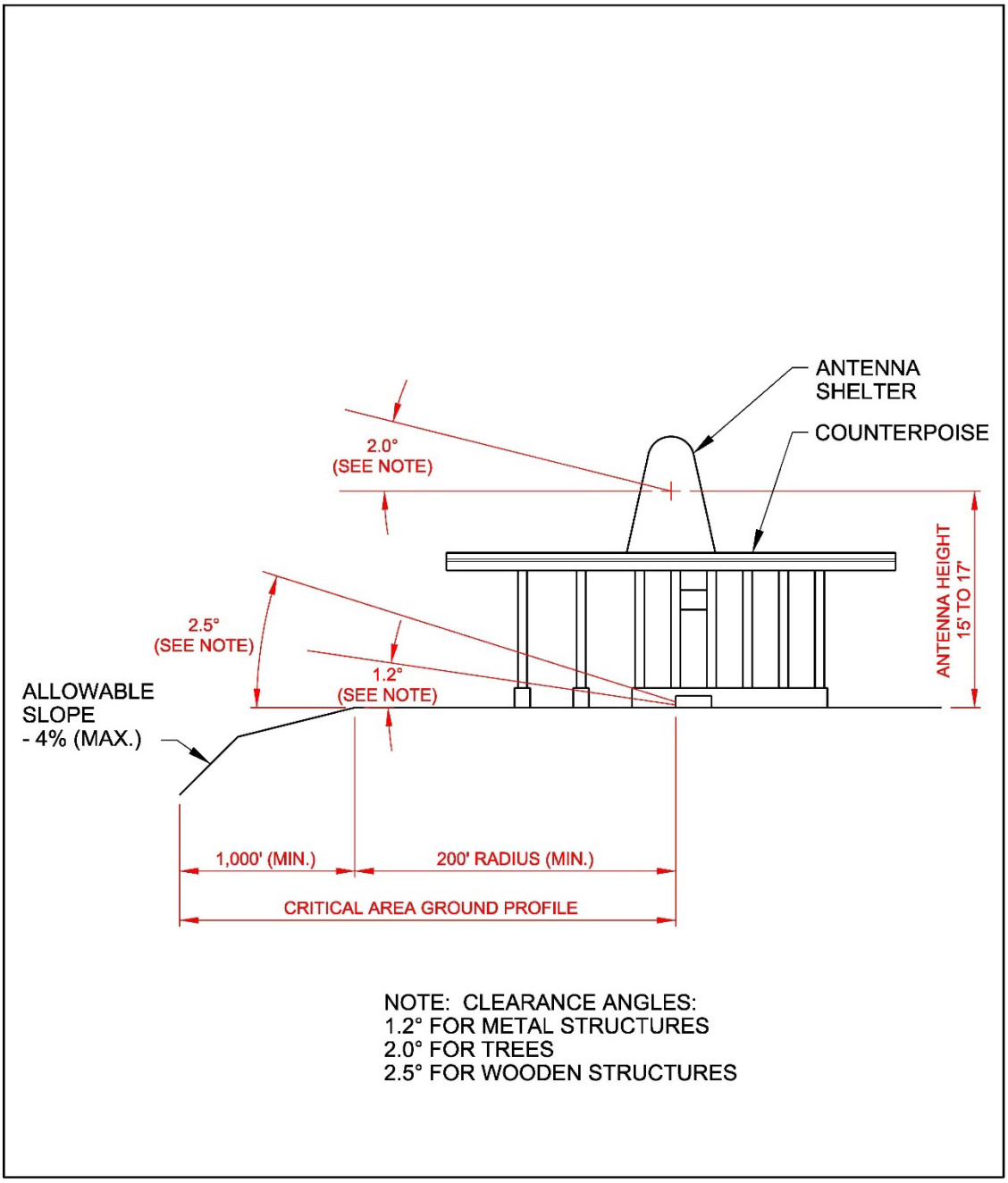


**Figure 3-7 VOR Facility Site Plan**

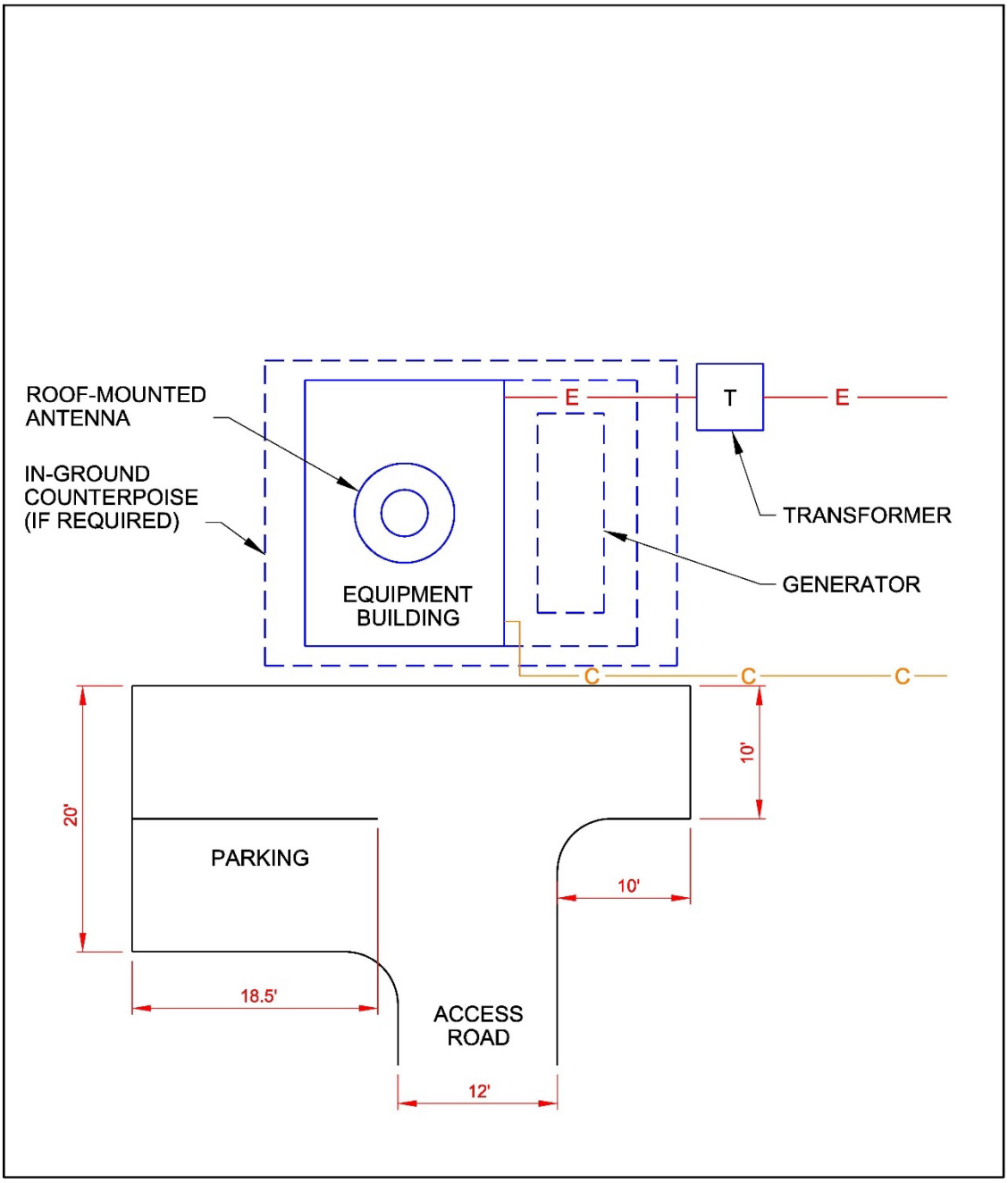


**Figure 3-8 VOR Building Layout**

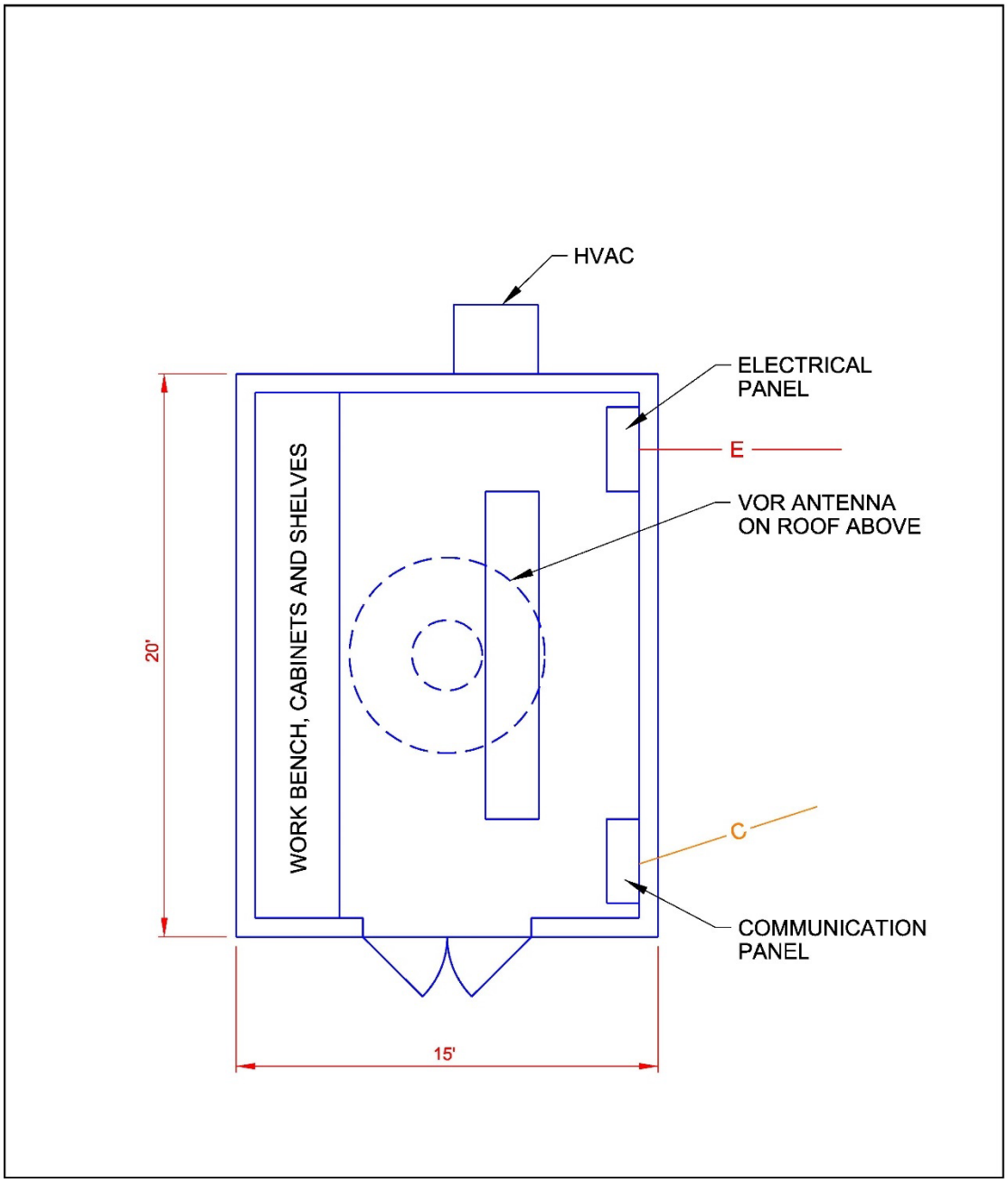
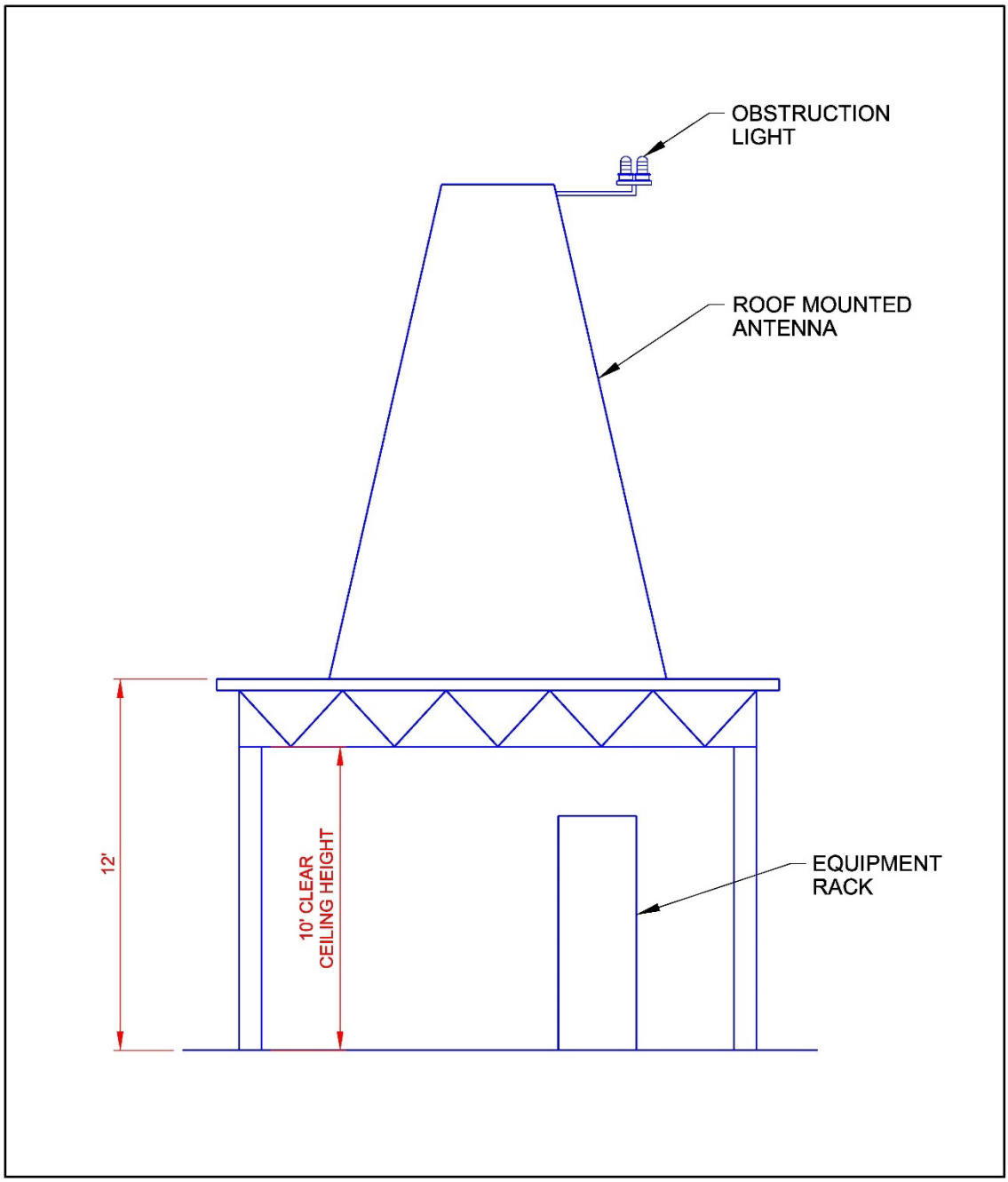


**Figure 3-9 VOR Building Section**



## 3-3 TACTICAL AIR NAVIGATION (TACAN) SYSTEMS.

### 3-3.1 Key Documents.

| | |
|---|---|
| UFC 3-260-01 | *Airfield and Heliport Planning and Design* |
| FAA AC 150/5300-13 | *Airport Design* |
| FAA Order 6780.5 | *DME Installation Standards Handbook Type FA-96-39 (Request from Lead Service Agency)* |
| FAA Order 6780.8 | *Distance Measuring Equipment (DME) Installation Standards Handbook Type FA-9783 (Request from Lead Service Agency)* |
| FAA Order 6820.10 | *VOR, VOR/DME, and VORTAC Siting Criteria* |
| AF T.O. 31Z3-822-2 | *Air Traffic Control Landing Systems (ATCALS) Site Requirements 404L* |

### 3-3.2 Siting.

If possible, locate the TACAN in an area adjacent to the intersection of the primary runways. Locate the facility at the minimum distances from the centerline of runways and taxiways according to Table 3-3 and Figure 3-10. When the facility is located off the airfield, consider selecting a site with one or more flight path courses providing an approach to the primary runway. When sited outside these distances, include obstruction lighting if the VOR is within the primary surface or penetrates the imaginary surfaces defined in UFC 3-260-01. See FAA Order 6820.10 for more details about siting considerations.

**Table 3-3 TACAN Siting Dimensions**

| Item | | Legend in Figures | Requirement | | Remarks |
|---|---|---|---|---|---|
| No. | Description | | | | |
| 1 | Distance to Runway Centerline | A | Army | 250 ft (76 m) | Source: UFC 3-260-01, App. B, Section 13 |
| | | | Navy | 750 ft (229 m) | Source: UFC 4-141-10N (Jan 2004) |
| | | | Air Force | 500 ft (152 m) | Source: UFC 3-260-01, App. B, Section 13 |
| 2 | Distance to Taxiway Centerline | B | Army | 150 ft (46 m) | Source: UFC 3-260-01, App. B, Section 13 |
| | | | Navy | 250 ft (76 m) | Source: UFC 4-141-10N (Jan 2004) |
| | | | Air Force | 200 ft (61 m) | Source: UFC 3-260-01, App. B, Section 13 |

The area around the TACAN must be clear and reasonably smooth. Per FAA Order 6820.10, all obstructions within 1,000 feet (305 m) of the antenna are to be removed except as noted below.

- Trees and Forests. Trees close to the TACAN antenna can cause severe scalloping. Single trees of moderate height (up to 30 feet (9 m)) can be tolerated beyond 500 feet (152 m), but no closer. Groups of trees are not allowed within a 1,000-ft (305 m) radius or subtend a vertical angle of more than 2 degrees.
- Wire Fences. Ordinary farm-type wire fences about 4-feet (1.2 m) high are not permitted within 200 feet of the antenna; fences of the chain type 6 feet (1.8 m) or more in height) are not permitted within 500 feet (152 m) of the antenna; beyond these distances wire fence is not permitted to extend more than 0.5 degrees above the horizontal, measured from the antenna.
- Power and Control Lines. Install power and control line extensions underground for a minimum distance of 600 feet (183 m) from the antenna. Overhead power and control lines may be installed beyond 600 feet (183 m) if they are essentially radial to the antenna for a minimum distance of 1,200 feet (366 m).
- Structures. Structures are not allowed within 1,000 feet (305 m) of the antenna, except for buildings such as the transmitter building at a mountain top site located on a slope below the ground level of the antenna so that they are not visible from the antenna.

#### 3-3.2.1 Army and Air Force.

When used as a terminal navigational aid, the TACAN facility may be sited not less than 500 feet (152 m) from the centerline of any runway to the edge of the facilities, provided the elevation of the antenna does not exceed 50 feet (15 m) above the highest point of the adjacent runway centerline. For an on-base installation, the maximum angle of convergence between the final approach course and the runway centerline is 30 degrees. Align the final approach course to intersect the extended runway centerline 3,000 feet (914 m) outward from the runway threshold. When an operational advantage can be achieved, this point of intersect may be established at any point between the threshold and a point 5,200 feet (1,585 m) outward from the runway threshold. Also, where an operational advantage can be achieved, a final approach course which does not intersect the runway centerline or intersects at a point greater than 5,200 feet (1,585 m) outward from the runway threshold may be established, provided that such a course lies within 500 feet (152 m) laterally of the extended runway centerline at a point 3,000 feet (914 m) outward from the runway threshold.

### 3-3.3 Security.

TACAN facilities are normally located within the airfield restricted area. This siting typically meets the minimum security measures for external security. When the facility is located within a restricted area of a lower level of security or is located remote and

outside of an established restricted area, provide additional measures to meet the minimum security requirements for the level of security assigned to the facility.

### 3-3.4 Facility Design Guidance.

Provide an equipment building with roof-mounted antenna. See Figures 3-11 and 3-12 for typical site plan and building layout. See Figure 3-13 for a typical building section. See service-specific guidance for allowable building size. Typical building size is 300 square feet (28 square meters) to house the electronic equipment, monitoring and test equipment, and mechanical equipment.

Alternatively, a standard configured shelterized TACAN is a self-contained unit. If this type of facility is selected, provide a 20’ x 15’ (6 m x 4.6 m) concrete pad capable of supporting 12,000 lbs (5,443 kg) on four (4) 12” (300 mm) by 12” (300 mm) support feet.

A typical shelterized TACAN consists of the following items:

- Concrete Pad
- TACAN Shelter/ roof mounted TACAN Antenna
- Backup power (Generator) with associated power transfer equipment
- Electrical conduits/ Ground points (not specifically shown)
- Equipment shelter for the electrical transfer switch, electric main cutoff, and communications enclosures to minimize their exposure to the elements

#### 3-3.4.1 Site Work.

Provide an access road to allow maintenance vehicles access to the TACAN. Provide parking space for two maintenance vehicles. See Chapter 2, paragraph “Access and Parking” for roadway and parking area design requirements.

#### 3-3.4.2 Architectural Requirements.

Provide the following:

- Adequate space for equipment and equipment maintenance.
- Clear ceiling height of 10 feet (3 m).
- Work bench.

Do not provide a restroom.

Do not provide windows.

Consider the use of a premanufactured building.

### 3-3.4.3 Structural Requirements.

If not using a shelterized unit, provide sufficient roof area to accommodate the TACAN roof-mounted antenna and counterpoise. Consider an extended roof overhang or an antenna tower to accommodate a large antenna counterpoise.

#### 3-3.4.3.1 Concrete Pad.

For a shelterized unit, provide a minimum 15’ x 20’ (4.6 m x 6 m) concrete pad, minimum 6” (152 mm) thick with welded wire mesh, and minimum 10” (250 mm) thick at the edges tapering to 6” (150 mm) thick at 2’ (0.6 m) from all edges. In the 10” (250 mm) thick region, place reinforced steel bars (rebar) under the mesh at mid-depth. These requirements for thickness and reinforcement are for optimal soil conditions.

Size of concrete pad may be designed to be larger, as determined by the site-specific requirements.

Construct the concrete pad above the 100-year flood plain.

#### 3-3.4.3.2 Equipment Shed Requirements.

For a shelterized unit, provide a shed enclosure large enough to house the electrical and communication panels/enclosures. It may be three sided as shown in Figure 3-14 or completely enclosed.

### 3-3.5 Mechanical Requirements.

Provide HVAC system to maintain shelter temperature between 65° and 80° F (18° and 27°C). Provide humidity control to maintain humidity between 0 and 95%, with no condensation.

Air Force: See Environmental Control Unit requirements (e.g., allowable temperature and humidity ranges) in AF T.O. 31Z3-822-2, Chapter 3.

For a shelterized unit, the AN/FRN-48(V)3 TACAN is a self-contained unit with internal power distribution, emergency lighting, smoke detection equipment, thermostatically controlled environmental control unit with humidity controls, aircraft obstruction and exterior lighting. This equipment is designed, built, tested, and configuration managed by each Service. No additional mechanical systems are required.

### 3-3.6 Electrical Requirements.

To avoid potential interference with radar transmissions, locate power, communications, and control cables underground within 1,000 feet (305 m) from the facility. Ensure electrical systems do not interfere with radar transmissions.

Provide 120/240V, 100A, single-phase, 60 HZ commercial power service to the TACAN facility.

Air Force: See Commercial Power, Uninterruptible Power Supply, and Backup Power, in AF T.O. 31Z-822-2, Chapter 1. See Grounding, Bonding Shielding and Lightning Protection requirements in AF T.O. 31Z-822-2, Chapter 2.

### 3-3.6.1 Emergency Electrical Power.

Provide an emergency generator with automatic starting and switching capability as described in Chapter 2. Provide emergency power to the entire facility.

### 3-3.6.2 Grounding and Bonding.

Install two (2) ground rods, one on each 20’ (6 m) side of the concrete pad. Provide separate ground cables, one for the shelter and one for a direct path to ground from the antenna lightning arrestor.

### 3-3.6.3 Lighting.

The TACAN shelter comes equipped with an external red filtered door light and obstruction light. Provide additional lighting for the external electrical shed, but include features (aiming, shielding) not to interfere with night-time flight operations.

## 3-3.7 Communications.

Provide 12-strand single mode fiber optic cable or 25 twisted pair communications line to provide required connectivity for data and telephone.

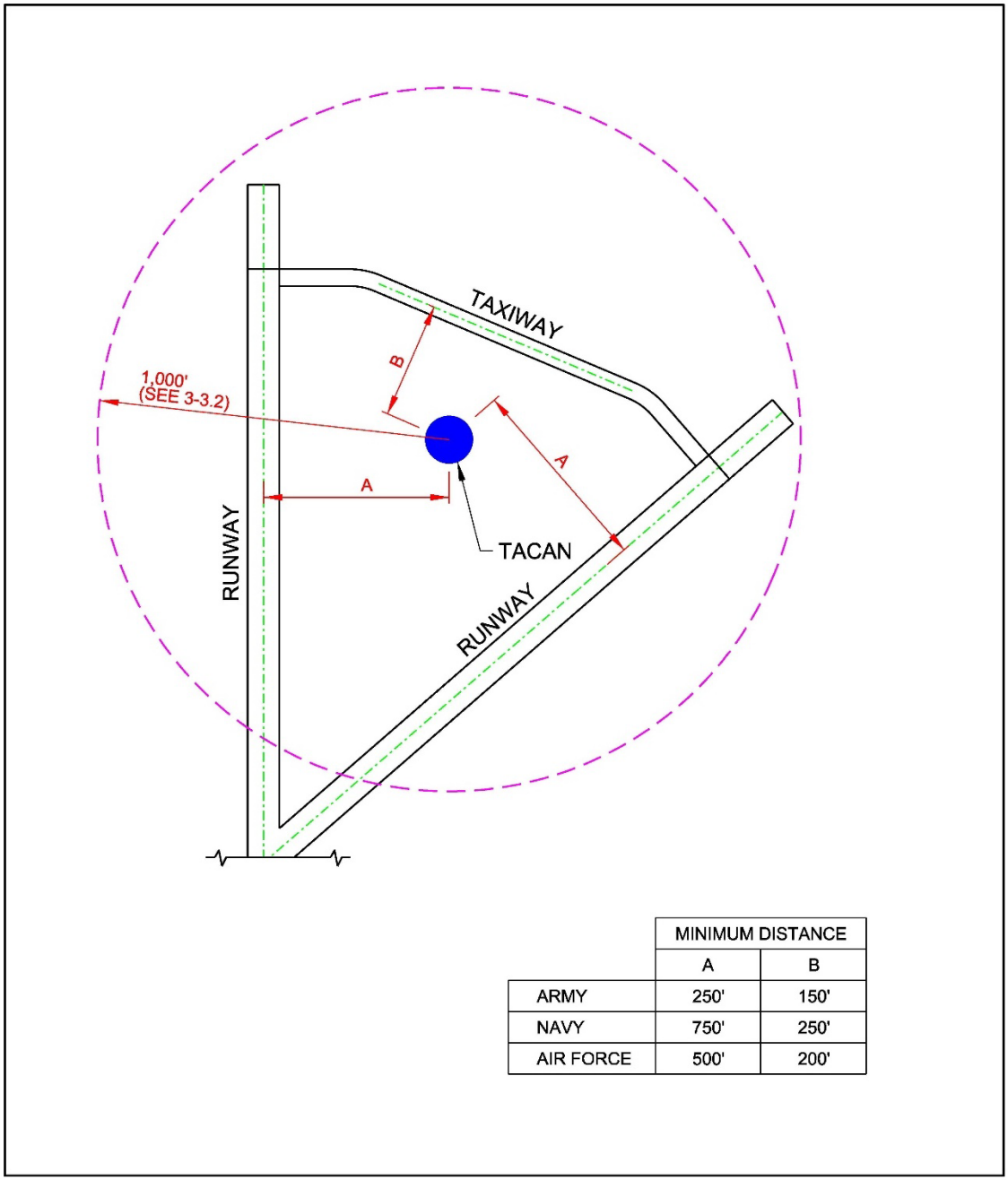
- Data connectivity from the TACAN Shelter to Remote Unit located in the ATC Tower.
- Data connectivity from the TACAN Shelter Fire Alarm to external monitoring system.
- Telephone line for distance support to troubleshoot system.

Air Force: See fiber optic cable and modem requirements in AF T.O. 31Z-822-2, Chapter 4.

## 3-3.8 Connection/Interrelation to other Facilities.

Connect a dedicated DSN-capable telephone connection through to the TACAN to facilitate distant support, troubleshooting, and corrective maintenance due to the remote location. Connect the TACAN to the ATC Tower via fiber optic cable for remote monitoring.

**Figure 3-10 Typical TACAN Facility Siting Criteria**




| | MINIMUM DISTANCE | |
|---|---|---|
| | A | B |
| ARMY | 250' | 150' |
| NAVY | 750' | 250' |
| AIR FORCE | 500' | 200' |

**Figure 3-11 Typical TACAN Facility Site Plan**

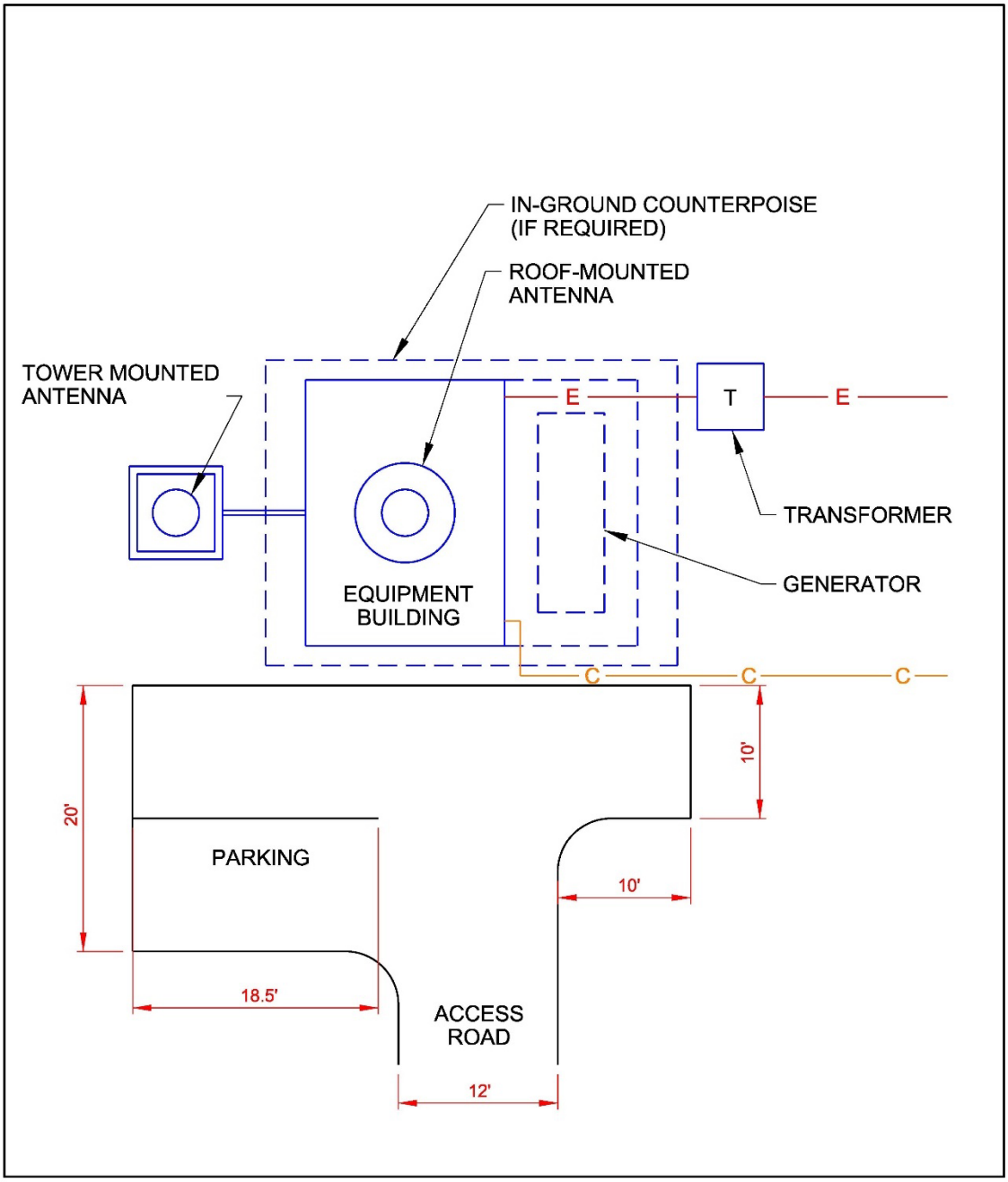


**Figure 3-12 Typical TACAN Building Layout**

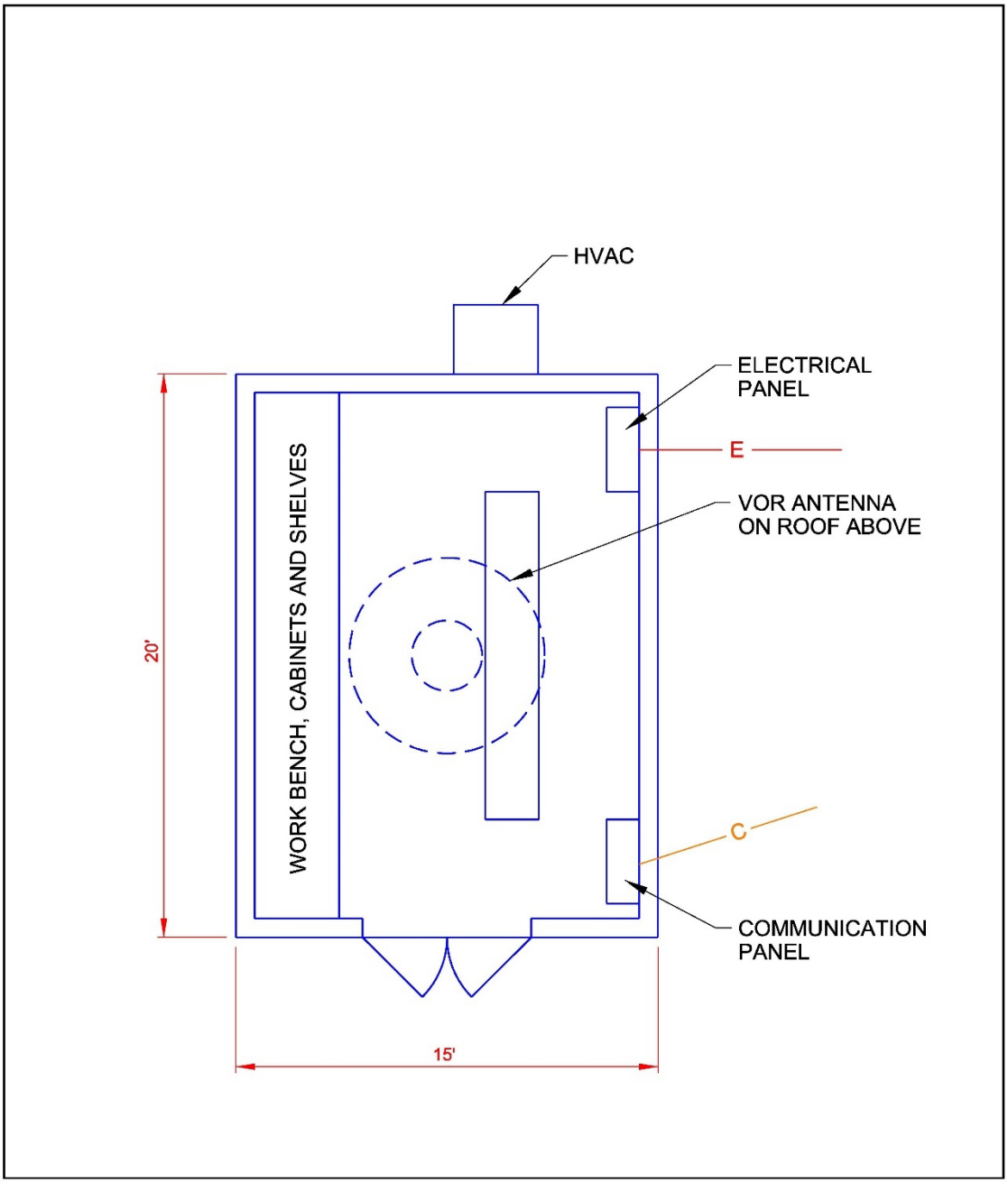


**Figure 3-13 Typical TACAN Building Section**

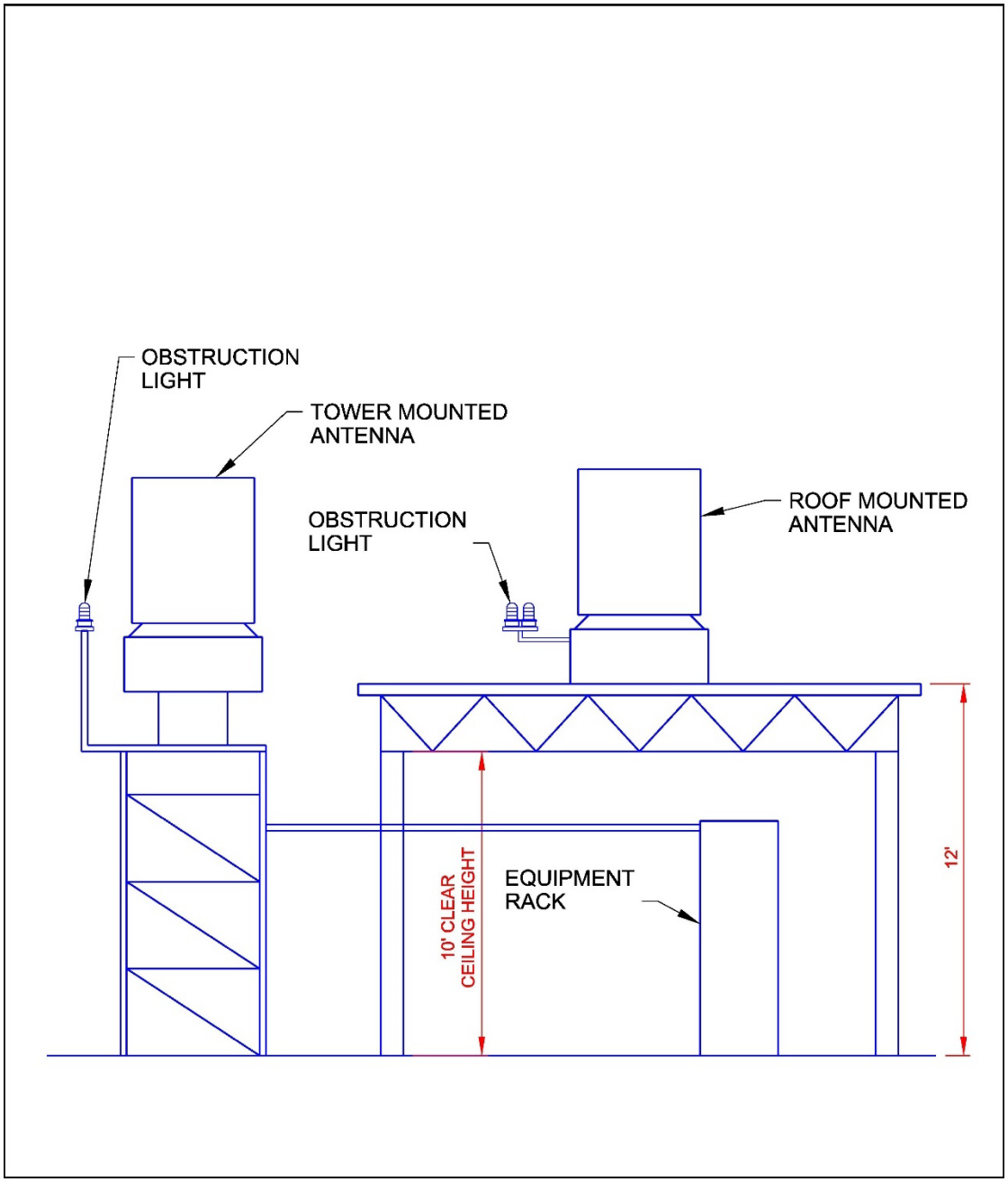


**Figure 3-14 Typical Shelterized TACAN Antenna with Adjacent Electrical Shed**

## 3-4 VERY HIGH FREQUENCY (VHF) OMNI-DIRECTIONAL RANGE/ TACTICAL AIR NAVIGATION (VORTAC).

### 3-4.1 Key Documents.

| | |
|---|---|
| UFC 3-260-01 | *Airfield and Heliport Planning and Design* |
| FAA AC 150/5300-13 | *Airport Design* |
| FAA Order 6780.5 | *DME Installation Standards Handbook Type FA-96-39 (Request from Lead Service Agency)* |
| FAA Order 6780.8 | *Distance Measuring Equipment (DME) Installation Standards Handbook Type FA-9783 (Request from Lead Service Agency)* |
| FAA Order 6820.10 | *VOR, VOR/DME, and VORTAC Siting Criteria* |
| AF T.O. 31Z3-822-2 | *Air Traffic Control Landing Systems (ATCALS) Site Requirements 404L* |

### 3-4.2 Siting.

If possible, locate the VORTAC in an area adjacent to the intersection of the primary runways. Locate the facility at the minimum distances from the centerline of runways and taxiways according to Table 3-4 and Figure 3-15. When the facility is located off the airfield, consider selecting a site with one or more flight path courses providing an approach to the primary runway. When sited outside these distances, include obstruction lighting if the VORTAC is within the primary surface or penetrates the imaginary surfaces defined in UFC 3-260-01. See FAA Order 6820.10 for more details about siting considerations.

**Table 3-4 VORTAC Siting Dimensions**

| Item | | Legend in Figures | Requirement | | Remarks |
|---|---|---|---|---|---|
| No. | Description | | | | |
| 1 | Distance to Runway Centerline | A | Army | 250 ft (76 m) | Source: UFC 3-260-01, App. B, Section 13 |
| | | | Navy | 750 ft (229 m) | Source: UFC 4-141-10N (Jan 2004) |
| | | | Air Force | 500 ft (152 m) | Source: UFC 3-260-01, App. B, Section 13 |
| 2 | Distance to Taxiway Centerline | B | Army | 150 ft (46 m) | Source: UFC 3-260-01, App. B, Section 13 |
| | | | Navy | 250 ft (76 m) | Source: UFC 4-141-10N (Jan 2004) |
| | | | Air Force | 200 ft (61 m) | Source: UFC 3-260-01, App. B, Section 13 |

The area around the VORTAC must be clear and reasonably smooth. Per FAA Order 6820.10, all obstructions within 1,000 feet (305 m) of the antenna are to be removed except as noted below.

- Trees and Forests. Trees close to the VORTAC antenna can cause severe scalloping. Single trees of moderate height (up to 30 feet (9 m) may be tolerated beyond 500 feet (152 m), but no closer. Groups of trees are not allowed within a 1,000-ft (305 m) radius or subtend a vertical angle of more than 2 degrees.
- Wire Fences. Ordinary farm-type wire fences about 4-feet (1.2 m) high are not permitted within 200 feet (61 m) of the antenna; fences of the chain type 6 feet (1.8 m) or more in height) are not permitted within 500 feet (152 m) of the antenna; beyond these distances wire fence is not permitted to extend more than 0.5 degrees above the horizontal, measured from the antenna.
- Power and Control Lines. Install power and control line extensions underground for a minimum distance of 600 feet (183 m) from the antenna. Overhead power and control lines may be installed beyond 600 feet (183 m) if they are essentially radial to the antenna for a minimum distance of 1,200 feet (366 m).
- Structures. Structures are not allowed within 1,000 feet (305 m) of the antenna, except for buildings such as the transmitter building at a mountain top site located on a slope below the ground level of the antenna so that they are not visible from the antenna.

#### 3-4.2.1 Army and Air Force.

When used as a terminal navigational aid, the VORTAC facility may be sited not less than 500 feet (152 m) from the centerline of any runway to the edge of the facilities, provided the elevation of the antenna does not exceed 50 feet (15 m) above the highest point of the adjacent runway centerline. For an on-base installation, the maximum angle of convergence between the final approach course and the runway centerline is 30 degrees. Align the final approach course to intersect the extended runway centerline 3,000 feet (914 m) outward from the runway threshold. When an operational advantage can be achieved, this point of intersect may be established at any point between the threshold and a point 5,200 feet (1,585 m) outward from the runway threshold. Also, where an operational advantage can be achieved, a final approach course which does not intersect the runway centerline or intersects at a point greater than 5,200 feet (1585 m) outward from the runway threshold may be established, provided that such a course lies within 500 feet (152 m) laterally of the extended runway centerline at a point 3,000 feet (914 m) outward from the runway threshold.

### 3-4.3 Security.

VORTAC facilities are normally located within the airfield restricted area. This siting typically meets the minimum security measures for external security. When the facility is

located within a restricted area of a lower level of security or is located remote and outside of an established restricted area, provide additional measures to meet the minimum security requirements for the level of security assigned to the facility.

### 3-4.4 Facility Design Guidance.

Provide an equipment building with roof-mounted antenna. See Figures 3-16 and 3-17 for typical site plan and building layout. See Figure 3-18 for a typical building section. See service-specific guidance for allowable building size. Typical building size is 300 square feet (28 square meters) to house the electronic equipment, monitoring and test equipment, and mechanical equipment.

#### 3-4.4.1 Site Work.

Provide an access road to allow maintenance vehicles access to the VORTAC. Provide parking space for two maintenance vehicles. See Chapter 2, paragraph “Access and Parking” for roadway and parking area design requirements.

#### 3-4.4.2 Architectural Requirements.

Provide the following:

- Adequate space for equipment and equipment maintenance.
- Clear ceiling height of 10 feet (3 m).
- Work bench.

Do not provide a restroom.

Do not provide windows.

Consider the use of a premanufactured building.

#### 3-4.4.3 Structural Requirements.

Provide sufficient roof area to accommodate the VORTAC roof mounted antenna and counterpoise. Consider an extended roof overhang or an antenna tower to accommodate a large antenna counterpoise.

##### 3-4.4.3.1 Concrete Pad.

For a shelterized unit, provide a minimum 15’ x 20’ (4.6 x 6 m) concrete pad, minimum 6” (150 mm) thick with welded wire mesh, and minimum 10” (250 mm) thick at the edges tapering to 6” (150 mm) thick at 2’ (0.6 m) from all edges. In the 10” (250 mm) thick region, place reinforced steel bars (rebar) under the mesh at mid-depth. These requirements for thickness and reinforcement are for optimal soil conditions.

Size of concrete pad may be designed to be larger, as determined by the site-specific requirements.

Construct the concrete pad above the 100-year flood plain.

### 3-4.5 Mechanical Requirements.

Provide HVAC system to maintain shelter temperature between 65° and 80° F (18° and 27°C). Provide humidity control to maintain humidity between 0 and 95%, with no condensation.

Air Force: See Environmental Control Unit requirements (e.g., allowable temperature and humidity ranges) in AF T.O. 31Z3-822-2, Chapter 3.

### 3-4.6 Electrical Power.

To avoid potential interference with radar transmissions, locate power, communications, and control cables underground within 1,000 feet (305 m) from the facility. Ensure electrical systems do not interfere with radar transmissions.

Provide 120/240V, 100A, single-phase, 60 HZ commercial power service to the VORTAC facility.

Air Force: See Commercial Power, Uninterruptible Power Supply, and Backup Power, in AF T.O. 31Z-822-2, Chapter 1. See Grounding, Bonding Shielding and Lightning Protection requirements in AF T.O. 31Z-822-2, Chapter 2.

#### 3-4.6.1 Emergency Electrical Power.

Provide an emergency generator with automatic starting and switching capability as described in Chapter 2. Provide emergency power to the entire facility.

#### 3-4.6.2 Grounding and Bonding.

Install two (2) ground rods, one on each 20’ (6 m) side of the concrete pad. Provide separate ground cables, one for the shelter and one for a direct path to ground from the antenna lightning arrestor.

#### 3-4.6.3 Lighting.

The VORTAC shelter comes equipped with an external red filtered door light and obstruction light.

### 3-4.7 Communications.

Provide 12-strand single mode fiber optic cable or 25 twisted pair communications line to provide required connectivity for data and telephone.

- Data connectivity from the VORTAC Shelter to Remote Unit located in the ATC Tower.

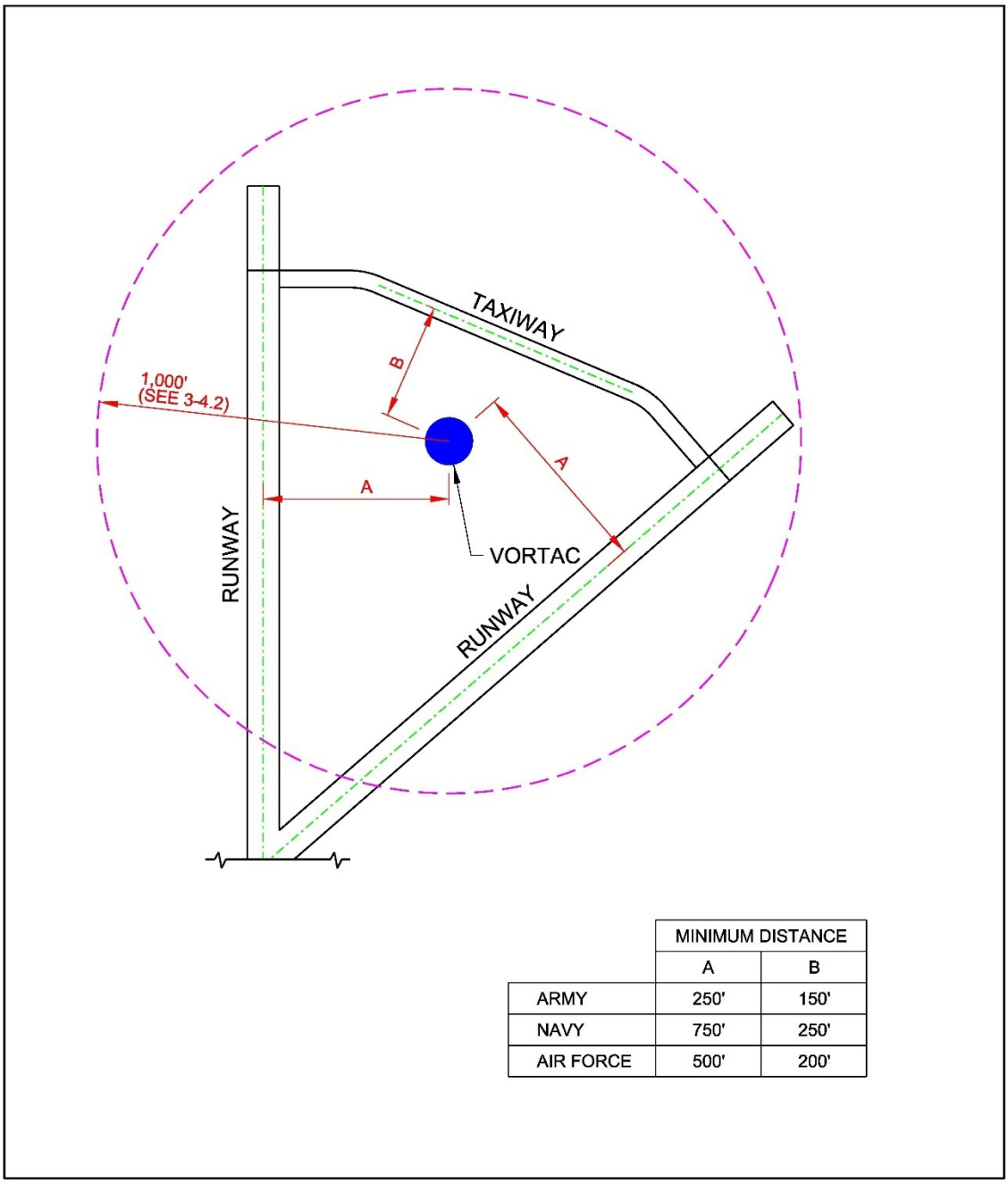
- Data connectivity from the VORTAC Shelter Fire Alarm to external monitoring system.
- Telephone line for distance support to troubleshoot system.

Air Force: See fiber optic cable and modem requirements in AF T.O. 31Z-822-2, Chapter 4.

### 3-4.8 Connection/Interrelation to other Facilities.

Connect a dedicated DSN-capable telephone connection through to the VORTAC to facilitate distant support, troubleshooting, and corrective maintenance due to the remote location. Connect the VORTAC to the ATC Tower via fiber optic cable for remote monitoring.

**Figure 3-15 VORTAC Facility Siting Criteria**




| | MINIMUM DISTANCE | |
|---|---|---|
| | A | B |
| ARMY | 250' | 150' |
| NAVY | 750' | 250' |
| AIR FORCE | 500' | 200' |

**Figure 3-16 VORTAC Facility Site Plan**

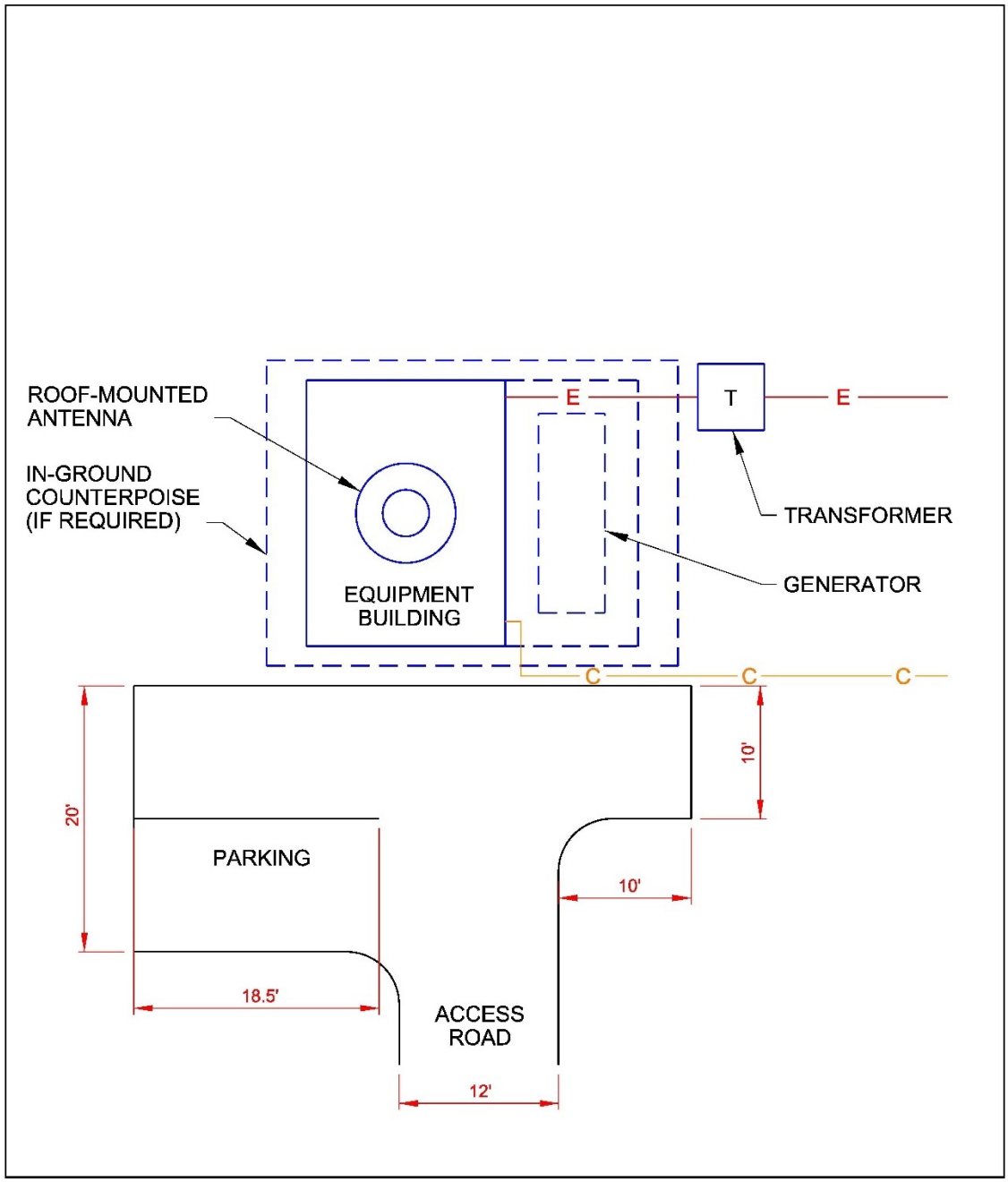


**Figure 3-17 VORTAC Building Layout**

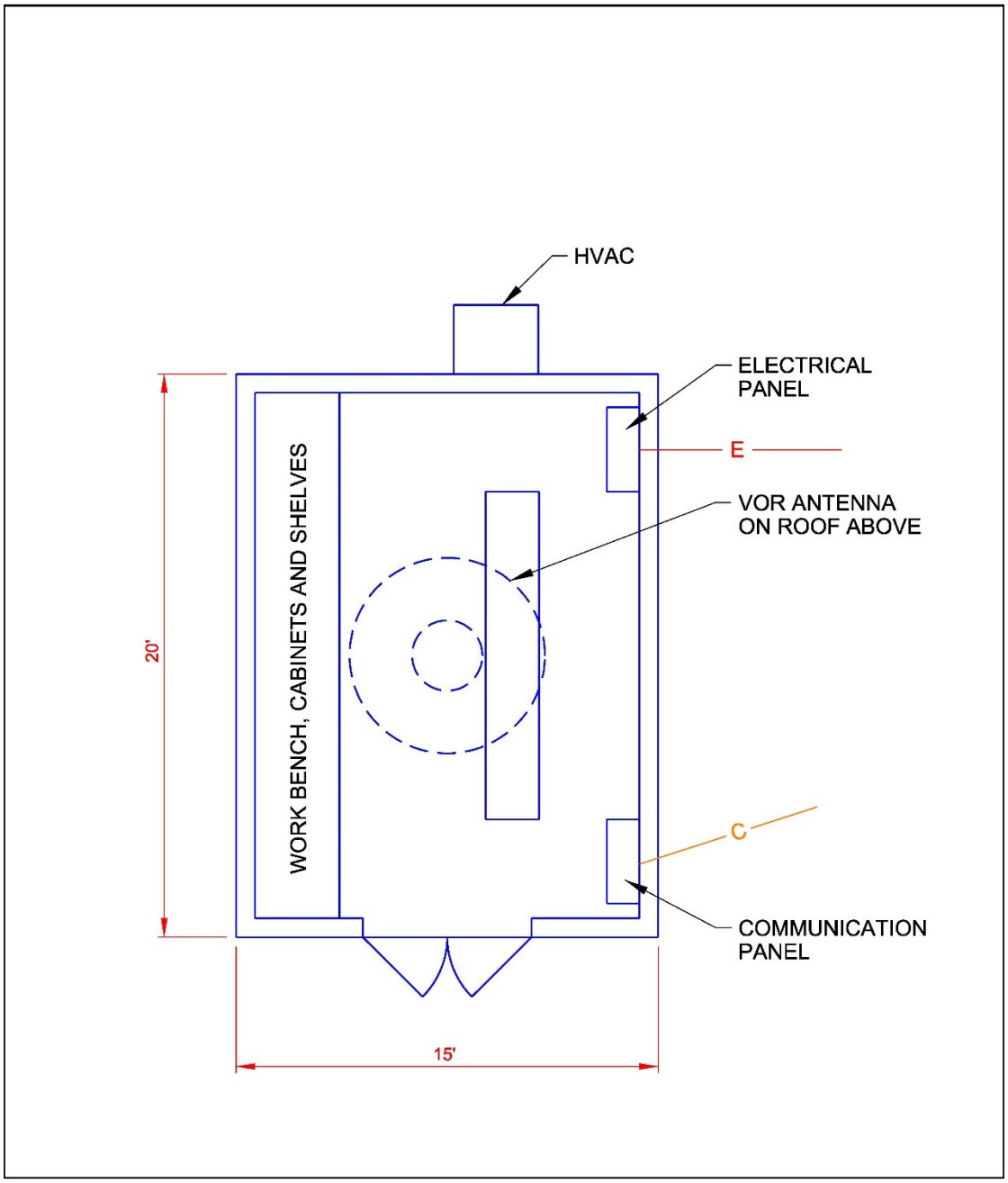
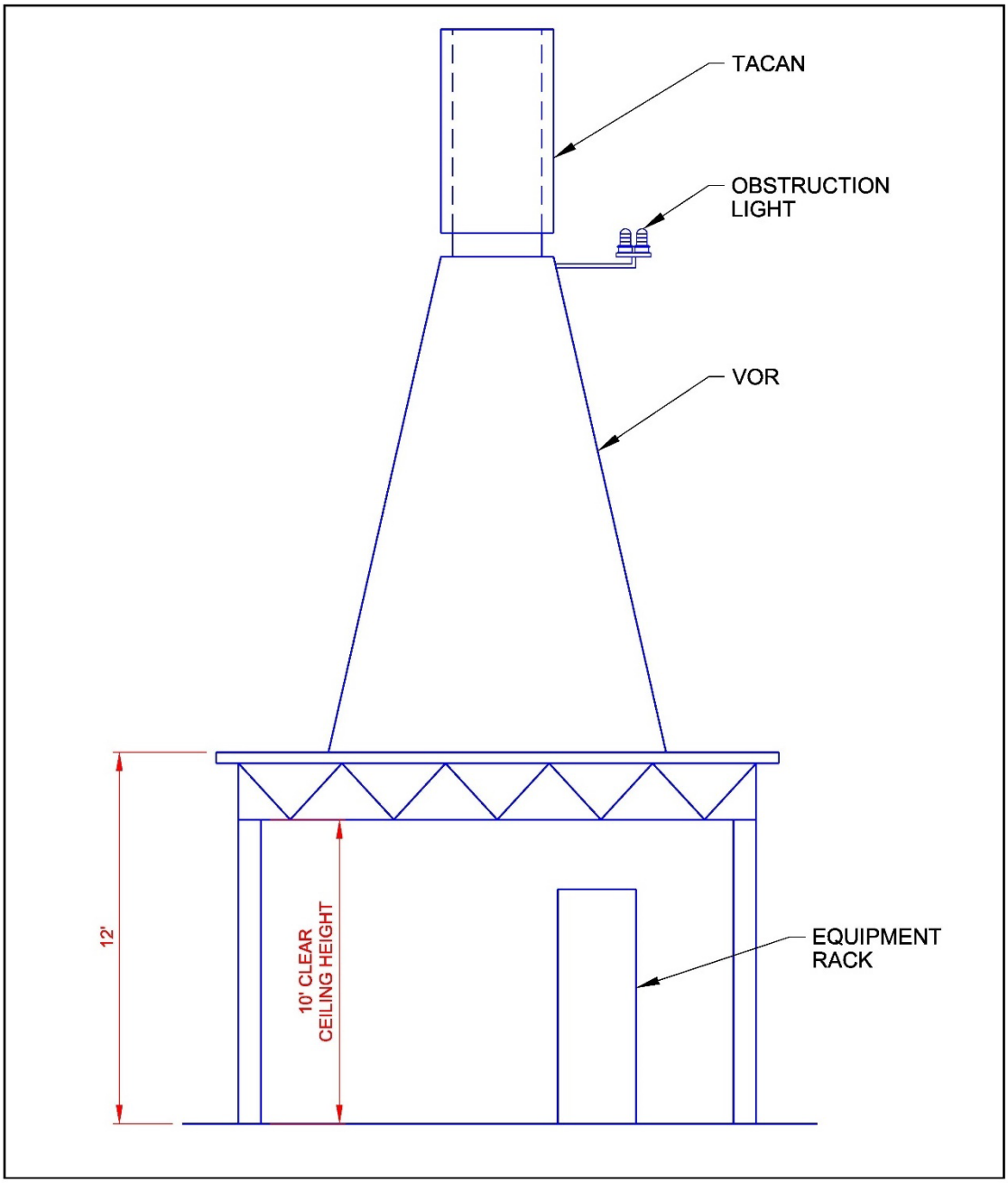


**Figure 3-18 VORTAC Building Section**



# CHAPTER 4 AIRCRAFT LANDING SYSTEMS

## 4-1 GENERAL INFORMATION.

### 4-1.1 Function.

The MLS, SBICLS, ILS and PAR facilities contain electronic equipment used in precision instrument approaches. These facilities are unattended.

#### 4-1.1.1 Microwave Landing System (MLS).

The MLS provides azimuth, distance, elevation, and glide path position to aircraft on a precision approach to the MLS instrumented runway. The MLS operates in a narrow band microwave frequency. Figure 4-1 shows a typical MLS antenna and shelter.

#### 4-1.1.2 Shore-Based Instrument Carrier Landing System (SBICLS).

The SBICLS is a microwave-based precision instrument landing aid that provides guidance to appropriately equipped Navy or Marine Corps carrier-based aircraft. The system can be used for conducting carrier-controlled approach training, field carrier landing practice (FBLP), or as a stand-alone instrument landing system. The system is comprised of the identical transmitter equipment used for shipboard aircraft landing operations but in a shore-based configuration. As of 2021, the AN/FRN-49(V) is the current equipment package being installed and replacing the older AN/TRN-28 system. Figure 4-2 shows a typical SBICLS Elevation Transmitter system.

#### 4-1.1.3 Instrument Landing System (ILS).

The ILS provides azimuth, distance, elevation, and glide path position to aircraft on a precision approach to the ILS instrumented runway. The ILS operates in the VHF and UHF radio bands. The ILS consists of two different antennas – Localizer (LOC) and Glide Slope (GS). Figures 4-3 and 4-4 show typical ILS antennas.

##### 4-1.1.3.1 Far Field Monitor (FFM).

ILS monitor systems are of three basic types: integral/aperture, near field and far field, which attempt to predict localizer and glide slope guidance quality on the glide path. A full-fledged Far Field Monitor provides the most complete response of the ILS system to effects which cause degradation to the glide path guidance.

The FFM is not required for CAT I ILS systems; however, it is required for CAT II and above systems. The FFM is considered part of the localizer system. However, it is sited at the opposite end of the runway from the localizer antenna array. Figure 4-5 illustrates a typical FFM antenna.

#### 4-1.1.4 Precision Approach Radar (PAR).

The PAR is an unattended self-contained radar system. The PAR detects azimuth, elevation, and range information of aircraft on final landing approach to PAR

instrumented runways. This information is displayed in the Military Terminal Radar Approach Control Facility (MTRACON). The PAR can be mounted on a fixed base or on a turntable. Figure 4-6 illustrates a typical PAR.

**Figure 4-1 Typical MLS Facility**

**Figure 4-2 SBICLS Elevation Transmitter Station**

**Figure 4-3 ILS Localizer Antenna Array**

**Figure 4-4 ILS Glide Slope Antenna and Equipment Shelter**

**Figure 4-5 Typical Far Field Monitor**

**Figure 4-6 Typical PAR-2000/AN/FPN-68 PAR**

## 4-2 MICROWAVE LANDING SYSTEM (MLS)

### 4-2.1 Key Documents.

| | |
|---|---|
| UFC 3-260-01 | *Airfield and Heliport Planning and Design* |
| FAA Order 6830.5 | *Criteria for Siting Microwave Landing Systems* |
| FAA-STD-019f | *FAA Standard, Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities* |
| AF T.O. 31Z3-822-2 | *Air Traffic Control Landing Systems (ATCALS) Site Requirements 404L* |

### 4-2.2 Siting.

Locate the azimuth transmitter on the extended runway centerline, 700 to 1,200 feet (213 to 366 m) from the end of runway. Locate the elevation transmitter 600 to 900 feet (183 to 274 m) set back from the runway approach threshold and offset 250 to 600 feet (76 to 183 m) from runway centerline on the runway side opposite of taxiways. See Figure 4-7 for an illustration of the general siting criteria.

#### 4-2.2.1 MLS Obstacle Free Zones.

The MLS obstacle free zones shown in Figures 4-8 and 4-9 must always remain clear of fixed objects as well as moving aircraft and vehicles.

### 4-2.3 Security.

MLS facilities are normally located within the airfield restricted area which would typically meet the minimum security measures for external security. When the facility is located within a restricted area of a lower level of security or is located remote and outside of an established restricted area, determine the additional measures required to meet the minimum security requirements for the level of security assigned to the facility.

### 4-2.4 Facility Design Guidance.

#### 4-2.4.1 Site Work.

The MLS consists of two stations, an azimuth station and an elevation station.

Provide an access road to allow access to both MLS stations. Provide parking space for two maintenance vehicles. Typical site layouts are illustrated in Figures 4-8 and 4-9. See Chapter 2, paragraph “Access and Parking” for roadway and parking area design requirements.

### 4-2.4.2 Architectural Requirements.

There are no architectural requirements for the MLS.

### 4-2.4.3 Structural Requirements.

MLS transmitter equipment is provided in a self-contained structure by the system supplier. Provide concrete foundations flush with surrounding grade to mount equipment structures. Ensure MLS structures are frangible.

## 4-2.5 Mechanical Requirements.

Mechanical systems for the shelter system supporting the MLS are self-contained within the shelter and provided as part of the equipment package.

## 4-2.6 Electrical Power.

To avoid signal interference, install power, communications, and control cables underground within 1,000 feet (305 m) from the facility. Locate electrical equipment which is not frangible, such as transformers, outside the runway clear zone or primary surface. Ensure electrical systems do not interfere with radio transmissions.

Provide 120/240V, 100A, single-phase, 60 HZ commercial power service to the MLS equipment shelter.

### 4-2.6.1 Emergency Electrical Power.

MLS equipment is supplied with backup battery power. No emergency generator is required.

### 4-2.6.2 Lighting.

No site lighting is required. Obstruction lighting is provided with the equipment.

### 4-2.6.3 Grounding and Bonding.

Provide grounding and bonding systems in accordance with FAA STD-019f.

## 4-2.7 Communications.

Provide 12-strand single mode fiber optic cable or 25 twisted pair communications line to provide required connectivity for data and telephone.

- Data connectivity from the MLS Shelter to Remote Unit located in the ATC Tower.
- Data connectivity from the MLS Shelter Fire Alarm to external monitoring system.
- Telephone line for distance support to troubleshoot system.

Air Force: See fiber optic cable and modem requirements in AF T.O. 31Z-822-2, Chapter 4.

### 4-2.8 Connection/Interrelation to other Facilities.

Connect the MLS to the ATC Tower via fiber optic cable for remote monitoring.

**Figure 4-7 MLS Facility: Site Plan**

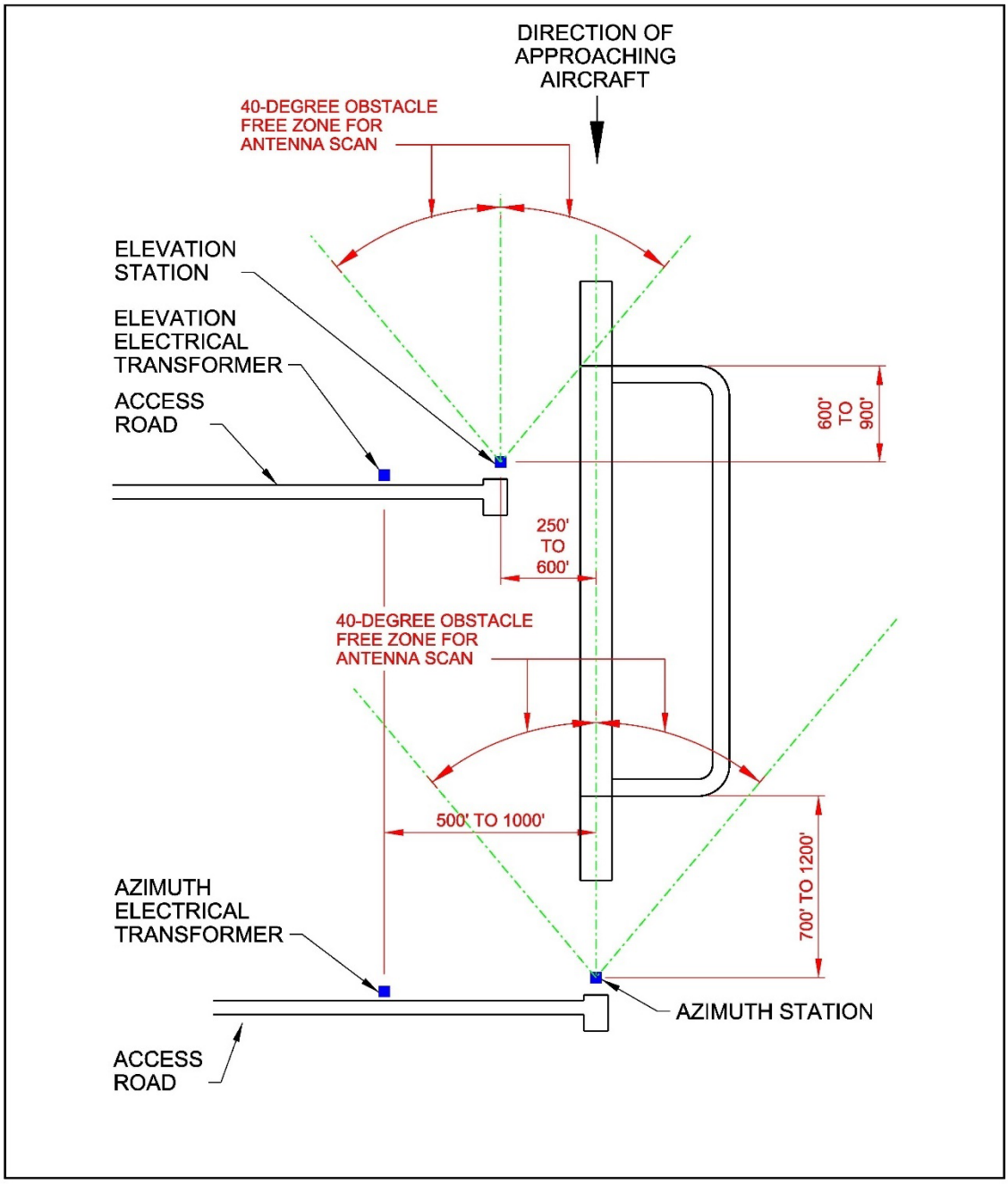


**Figure 4-8 MLS Facility: Azimuth Station Site Plan**

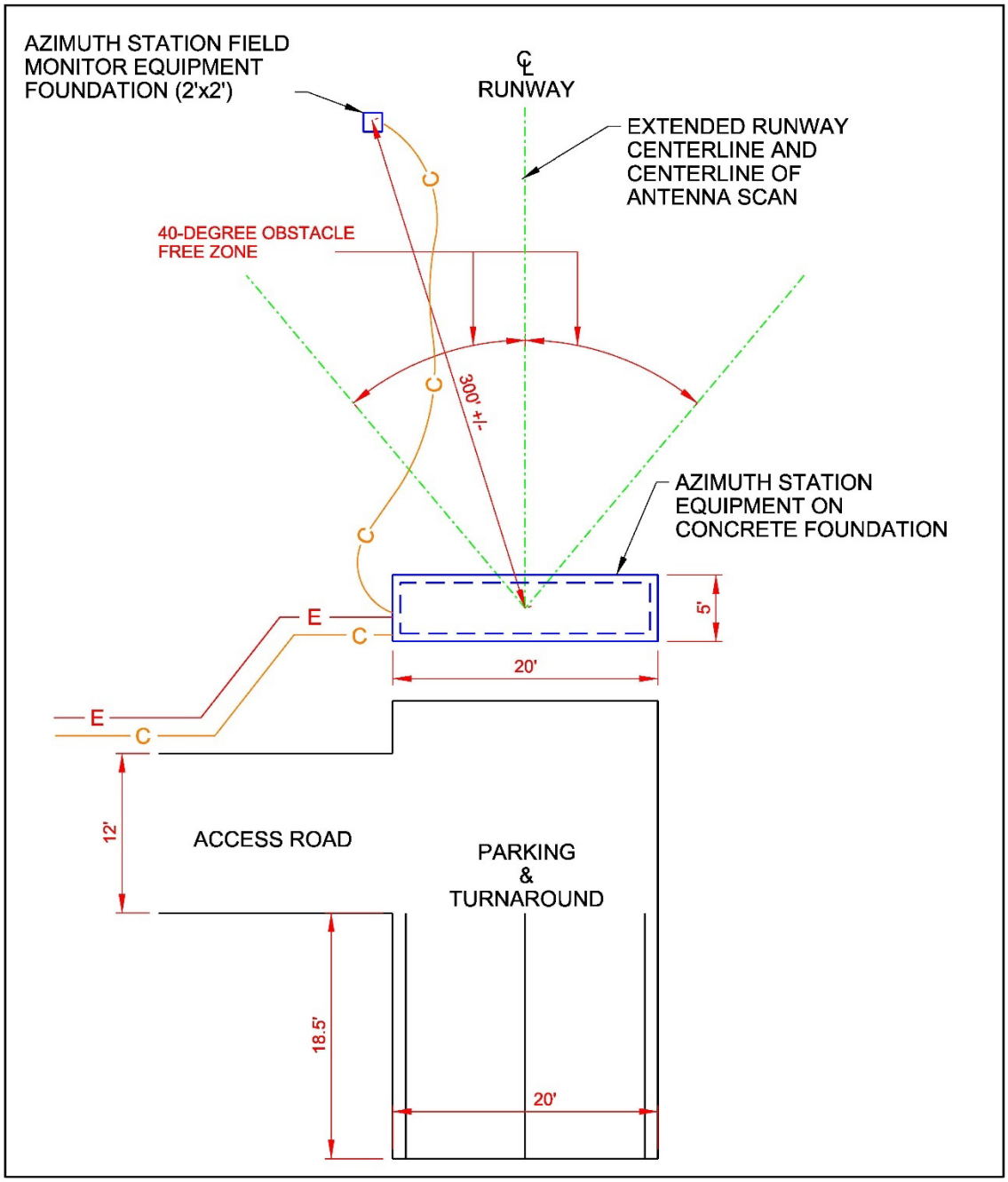
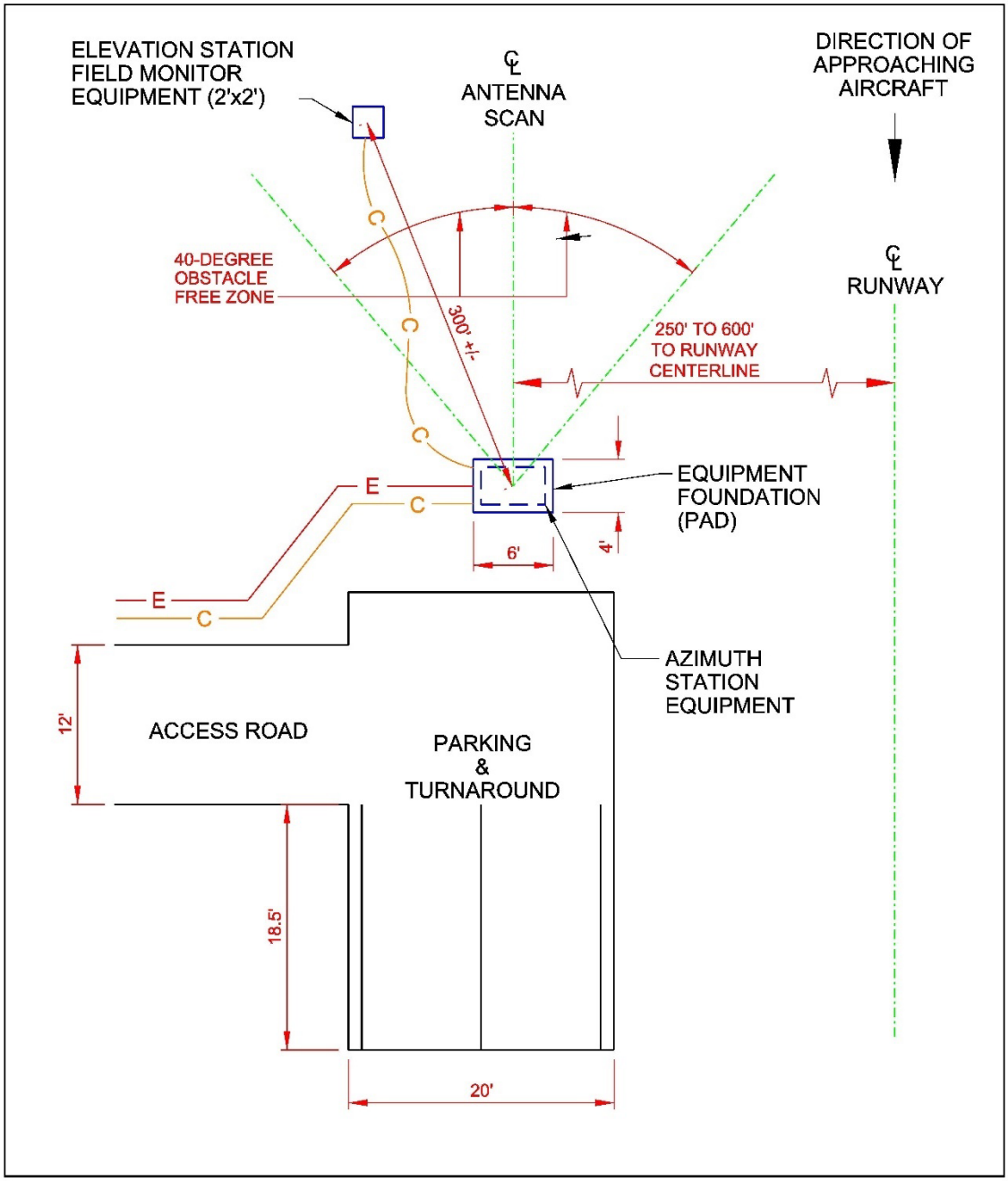


**Figure 4-9 MLS Facility: Elevation Station Site Plan**



## 4-3 SHORE-BASED INSTRUMENT CARRIER LANDING SYSTEMS.

### 4-3.1 Key Documents.

| | |
|---|---|
| 4K73-D2018-011 | *Facility Requirements Document (FRD) for the Shore Instrument Carrier Landing System (ICLS) AN/FRN-49(V)* |
| FAA AC 70/7460-1M | *Obstruction Marking and Lighting* |

### 4-3.2 Siting.

Locate the azimuth transmitter on the extended runway centerline. Locate the elevation transmitter adjacent to the runway, preferably 400-ft to 500-ft (122 to 152 m) from the runway centerline. See the FRD for specific distances. General siting requirements are illustrated in Figure 4-10.

Do not install the SBICLS if a Fresnel Lens Optical Landing System (FLOLS)/Improved Fresnel Lens Optical Landing System (IFLOLS) is not installed to the landing runway or a marked simulated carrier deck on a runway.

The SBICLS consists of three sites, as described below.

#### 4-3.2.1 Elevation Station Site.

This site consists of the elevation transmitter and its associated waveguide (W/G) horn which provides vertical guidance. The elevation transmitter group is located adjacent to the runway near the touchdown point associated with the simulated carrier deck markings. The elevation transmitter group may also be sited to provide for traditional vertical guidance to a runway touchdown point similar to an ILS glide slope antenna.

#### 4-3.2.2 Azimuth Station Site.

This site consists of the azimuth transmitter and its associated W/G horn, and it provides lateral guidance similar to an ILS localizer antenna array. The signal is provided through a transmitter located along the extended centerline or simulated carrier deck centerline at the far end of a runway approach.

#### 4-3.2.3 Operations Station Site.

This site consists of the transmitter control group and the transmitter control unit. The purpose of this site is to provide a graphical user interface, controls, system status and alerts, synchronization, and built-in test to maintenance personnel and operators.

#### 4-3.2.4 SBICLS Critical Areas.

The SBICLS critical areas shown in Figures 4-11 and 4-12 must always remain clear of fixed objects as well as moving aircraft and vehicles.

### 4-3.3 Security.

SBICLS facilities are normally located within the airfield restricted area which would typically meet the minimum security measures for external security.

### 4-3.4 Facility Design Guidance.

#### 4-3.4.1 Site Work.

Provide an access road to allow access to both SBICLS stations. Provide parking space for two maintenance vehicles. See Chapter 2, paragraph “Access and Parking” for roadway and parking area design requirements. Typical site layouts are illustrated in Figures 4-11 and 4-12.

#### 4-3.4.2 Architectural Requirements.

There are no architectural requirements for the SBICLS.

#### 4-3.4.3 Structural Requirements.

SBICLS transmitter equipment is provided in a self-contained structure by the system supplier. Provide concrete foundations flush with the surrounding grade to mount equipment structures. See FRD for additional requirements and foundation details.

### 4-3.5 Mechanical Requirements.

Mechanical systems for the shelter system supporting the SBICLS are self-contained within the shelter and provided as part of the equipment package.

### 4-3.6 Electrical Power.

To avoid signal interference, install power, communications, and control cables underground within 1,000 feet (305 m) from the facility.

Provide 120/240V, 100A, single-phase, 60 HZ commercial power service to each SBICLS equipment shelter. The minimum required transformer size for each SBICLS shelter is 15 kVA, in a pad-mounted configuration.

#### 4-3.6.1 Emergency Electrical Power.

Emergency generators are not supplied with the ICLS equipment and are not required for IFR approach certification. The requirements for individual generators at the equipment shelter sites are a base-level determination. If required, the base will provide the generator.

An integrated battery backup UPS will be supplied as part of each ICLS transmitter shelter. The UPS is rated for 4 hours at full load and meets the requirements for IFR certification.

### 4-3.6.2 Lighting.

No site lighting is required. Provide obstruction lights in accordance with FAA AC 70/7460-1 on transmitter shelters.

## 4-3.7 Communications.

Provide a minimum 12-strand single-mode fiber optic cable to each system (elevation and azimuth) through underground conduits and handholes.

## 4-3.8 Connection/Interrelation to other Facilities.

Each SBICLS system must be connected to the remote monitoring site (usually the Air Traffic Control Tower) with fiber optic cables. See the FRD for additional details.

**Figure 4-10 SBICLS Facility: Site Plan**

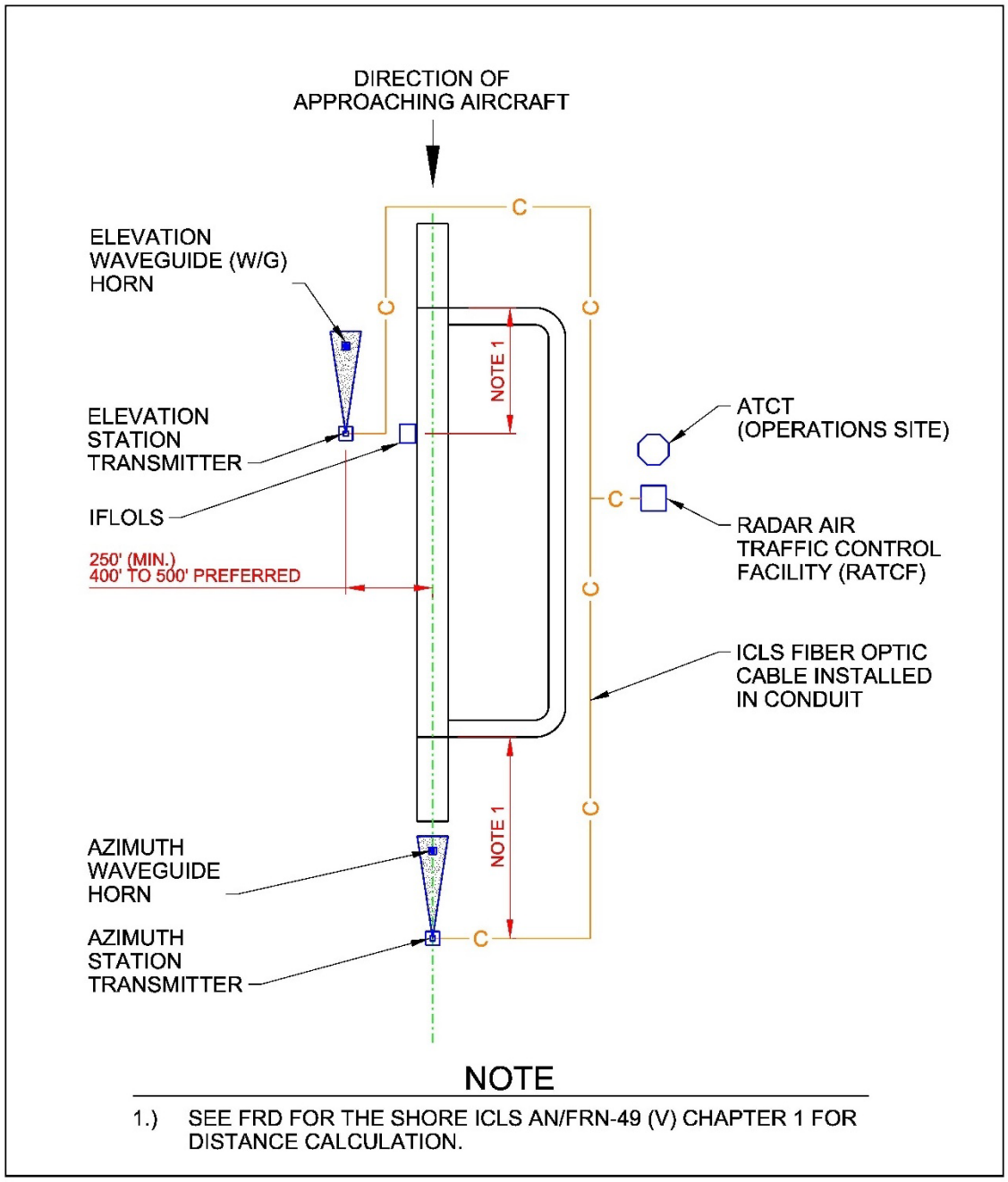


**Figure 4-11 SBICLS: Azimuth Station Site Plan**

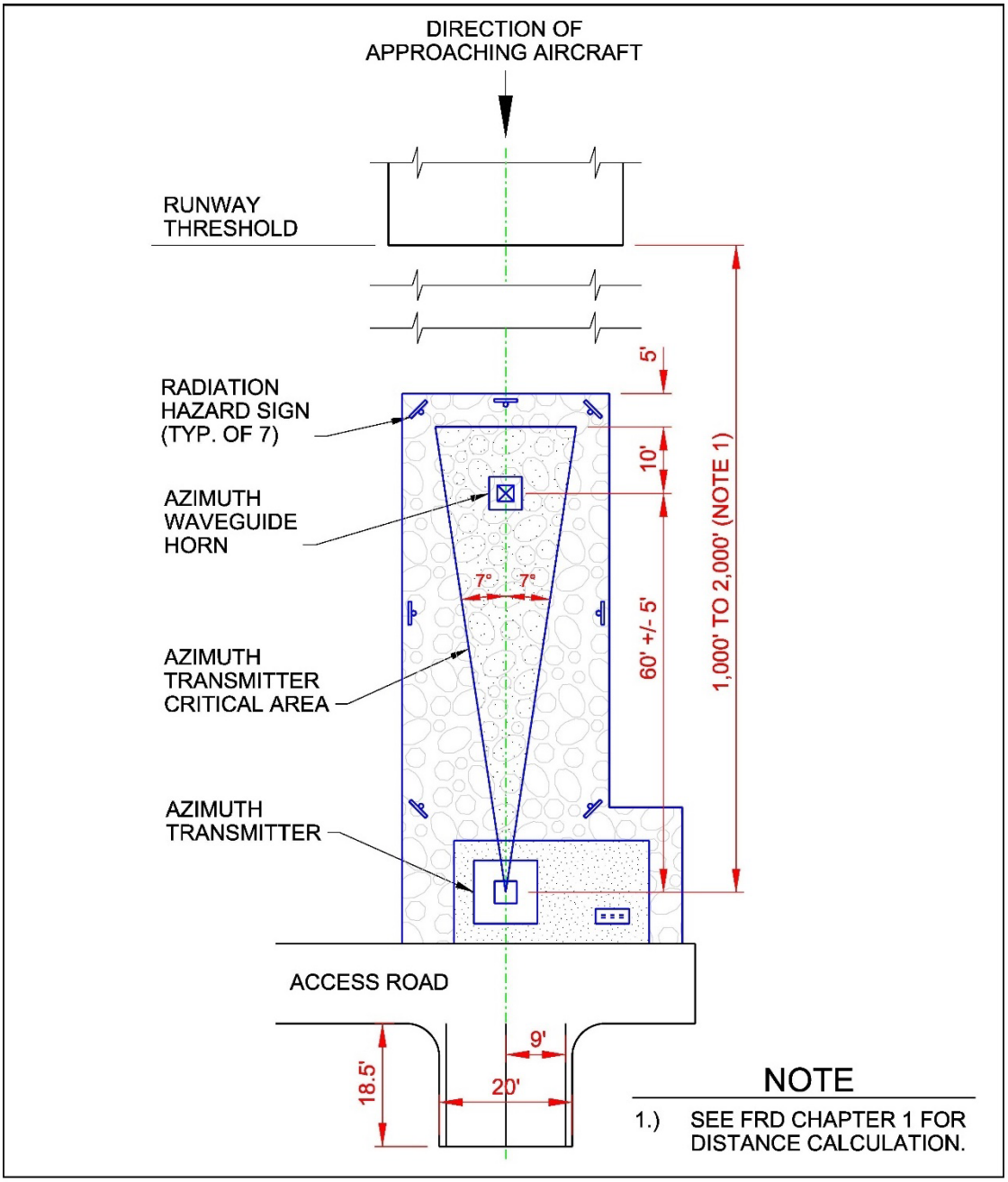
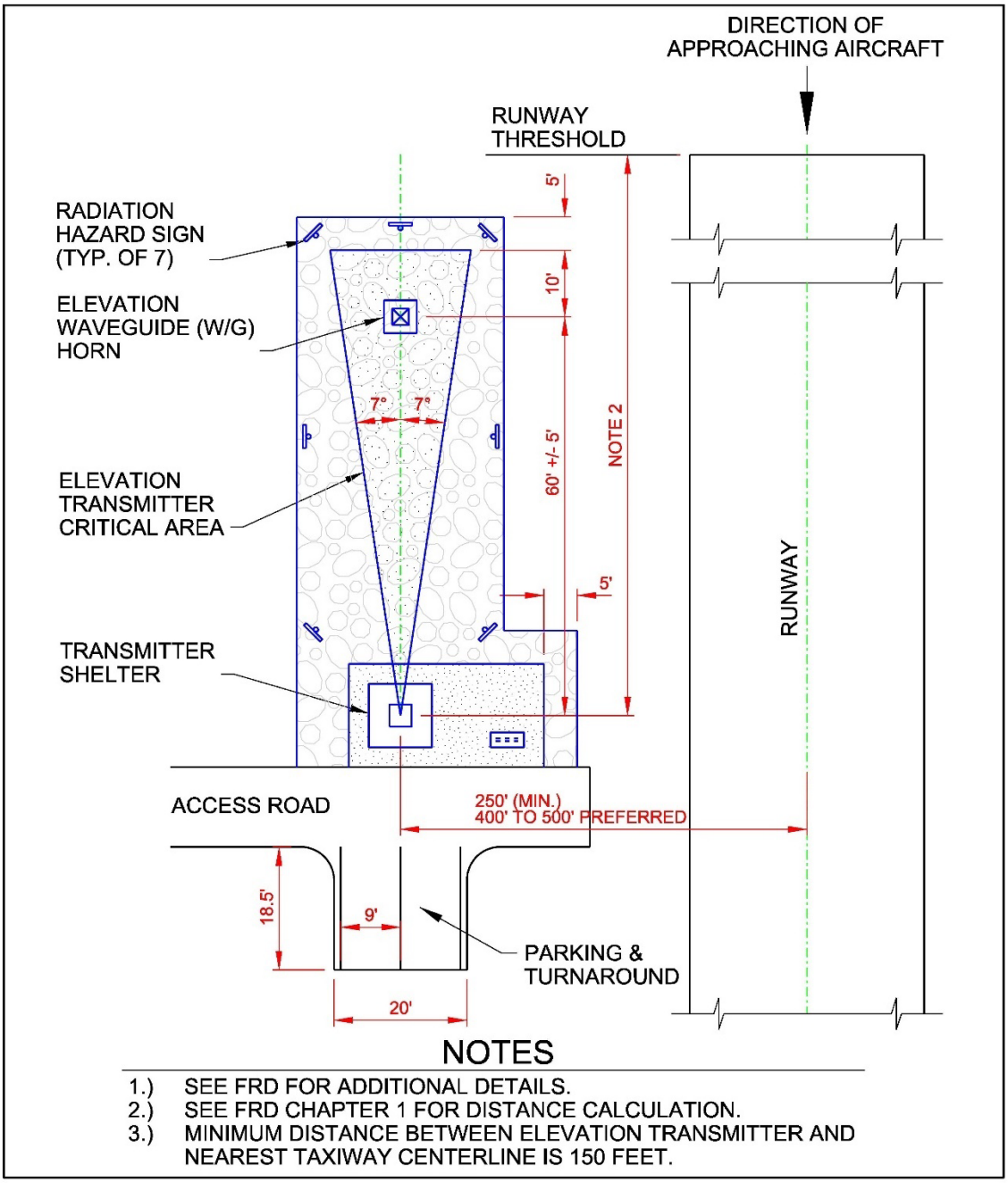


**Figure 4-12 SBICLS Facility: Elevation Station Site Plan**



## 4-4 INSTRUMENT LANDING SYSTEM (ILS).

### 4-4.1 Key Documents.

| | |
|---|---|
| UFC 3-260-01 | Airfield and Heliport Planning and Design |
| AF T.O. 31Z3-822-2 | Air Traffic Control Landing Systems (ATCALS) Site Requirements 404L |
| AF T.O. 31R4-2GRN30-32 | *Combined Maintenance Operating Instructions: Radio Transmitting Set (Localizer Station)* |
| FAA AC 150/5300-13 | *Airport Design* |
| FAA Order 6750.16 | *Siting Criteria for Instrument Landing Systems* |

### 4-4.2 Siting.

Provide separate facilities for glide slope (GS) antenna transmitter equipment, for localizer (LOC) antenna transmitter equipment and for Far Field Monitor (FFM) antenna equipment. Refer to FAA Order 6750.16 and FAA AC 150/5300-13. See Figure 4-13 for general layout requirements.

#### 4-4.2.1 General.

The ILS uses a line-of-sight signal from the LOC antenna and marker beacons and a reflected signal from the ground plane in front of the GS antenna.

a. ILS antenna systems are susceptible to signal interference sources such as power lines, fences, metal buildings, cell phones, etc.
b. Since ILS uses the ground in front of the GS antenna to develop the signal, this area must be free of high-growth vegetation and graded to remove surface irregularities.
c. GS and LOC equipment shelters are located near, but are not a physical part of, the antenna installation.
d. The FFM is considered part of the localizer system. However, it is sited at the opposite end of the runway from the localizer antenna array.

#### 4-4.2.2 ILS Localizer Antennas (Frangible).

Site the LOC antenna array between 1,000 feet and 2,000 feet (305 and 610 m) beyond the stop end of the runway. Siting must conform to approach-departure clearance surface criteria discussed in UFC 3-260-01, Chapters 3 and 4. Refer to FAA Order 6750.16 if standard localizer antenna placement is not an option. See Figure 4-16 for a typical LOC site plan.

a. The critical area depicted in Figure 4-14 surrounding the LOC antenna and extending toward and overlying the stop end of the runway must be clear of objects and high growth of vegetation.

b. The critical area must be smoothly graded. A constant +1.0% to -1.50% longitudinal grade with respect to the antenna is recommended. Allowable transverse grades from -0.5 percent to -3.0 percent, with smooth transitions between grade changes. Antenna supports are frangible and foundations must be flush with the ground.

c. Place the LOC equipment shelter at least 250 feet (76 m) to either side of the antenna array and within 30 degrees of the extended longitudinal axis of the antenna array.

#### 4-4.2.2.1 ILS Localizer Transmitter Shelter (Non-Frangible).

The ILS localizer transmitter shelter is sited adjacent to the localizer antenna array. It must be located at least 250 feet (76 m) from the extended runway centerline, or a waiver is required.

### 4-4.2.3 ILS Glide Slope Antenna (Non-Frangible).

Locate the antenna mast or monitor a minimum distance of 400 feet (122 m) from the runway centerline to the centerline of the antenna, and not exceeding 55 feet (17 m) in height above the nearest runway centerline elevation. A mast height of over 55 feet (17 m) is permitted if the minimum distance from the runway centerline is increased by 10 feet (3 m) for each 1 foot (0.3 m) the mast exceeds 55 feet (17 m). When the mast cannot, for technical or economic reasons, be located at a minimum distance of 400 feet (122 m) from the runway centerline, the minimum distance may be reduced to not less than 250 feet (76 m) from the centerline, provided the basic mast height of 55 feet is reduced 1 foot (0.3 m) for each 5 feet (1.5 m) it is moved toward the runway from the 400-foot (122 m) point. Glide slope monitor units are considered part of the parent equipment. Emergency power generators must be as close to the facilities they support as practical, but no closer than the glideslope main facility. See Figure 4-17 for a typical GS site plan.

a. The GS antenna may be located on either side of the runway. The most reliable operation is obtained when the GS is located on the side of the runway offering the least possibility of signal reflections from buildings, power lines, vehicles, aircraft, etc. The GS critical area is illustrated in Figure 4-15.

b. The critical area must be smoothly graded. A constant +1.0 percent to -1.50 percent longitudinal grade with respect to the antenna is recommended. Allowable transverse grades range from -0.5 percent to -3.0 percent, with smooth transitions between grade changes. Antenna supports are frangible and foundations must be flush with the ground.

c. Signal quality is dependent upon the type of antenna used and the extent of reasonably level ground immediately in front of the antenna.

d. The GS equipment shelter is located behind the antenna and a minimum of 400 feet (122 m) from the runway centerline.

#### 4-4.2.3.1 ILS End Fire Glide Slope Antenna (Frangible).

Site in accordance with FAA Order 6750.16. For the end-fire glide slope, the antenna array typically extends to 25 feet (7.6 m) from the runway edge. This is allowed due to antenna frangibility.

### 4-4.2.4 Far Field Monitor (FFM).

The FFM is not required for CAT I ILS systems; however, it is required for CAT II and above systems. The FFM is considered part of the localizer system. However, it is sited at the opposite end of the runway from the localizer antenna array. Typical locations are 365.8 meters (1,200 feet) to 914.4 meters (3,000 feet) prior to the landing threshold. FFM antenna height is determined by line of sight to the localizer antenna array. The line-of-sight requirement can be relaxed if satisfactory localizer signal reception is proven with a portable ILS receiver at the proposed lower height of the FFM site. Just as with the localizer antenna array, the FFM antenna must not penetrate the approach-departure clearance surface criteria discussed in UFC 3-260-01, Chapters 3 and 4. Army siting requirements are contained in FAA Order 6750.16.

## 4-4.3 Security.

ILS facilities are normally located within the airfield restricted area which would typically meet the minimum security measures for external security. When the facility is located within a restricted area of a lower level of security or is located remote and outside of an established restricted area, determine the additional measures required to meet the minimum security requirements for the level of security assigned to the facility.

## 4-4.4 Facility Design Guidance.

### 4-4.4.1 Site Work.

The ILS consists of two stations, a localizer and antenna station, and a glide slope equipment station.

Provide a roadway to allow access to the LOC and GS antennas. Provide parking space for two maintenance vehicles.

When included, the FFM also requires an access road and a parking space for one maintenance vehicle.

See Chapter 2, paragraph “Access and Parking” for roadway and parking area design requirements.

### 4-4.4.2 Architectural Requirements.

There are no architectural requirements for the ILS. Localizer and Glide Slope shelters are prefabricated units.

### 4-4.4.3 Structural Requirements.

ILS transmitter equipment is provided in a self-contained structure by the system supplier. Provide concrete foundations flush with grade that extend below the frost depth to mount equipment structures. Ensure ILS structures are frangible.

The LOC station requires an 18 by 20-foot (5.5 by 6 m) concrete pad for the localizer equipment shelter and a 12 by 18-foot (3.7 by 5.5 m) concrete pad for the glide slope equipment shelter.

The FFM requires pier foundations flush with grade that extend below the frost depth.

## 4-4.5 Mechanical Requirements.

Localizer and Glide Slope shelters are prefabricated units that include HVAC systems.

Air Force: See Environmental Control Unit requirements (e.g., allowable temperature and humidity ranges) in AF T.O. 31Z3-822-2, Chapter 3.

## 4-4.6 Electrical Power.

To avoid potential interference with antenna transmissions, install power, communications, and control cables underground within 1,000 ft (305 m) of each facility. Locate electrical equipment which is not frangible, such as transformers, outside the runway clear zone or primary surface. Ensure electrical systems do not interfere with radio transmissions.

Provide 120/240V, 100A, single-phase, 60 HZ commercial power service to the LOC and GS facility shelters.

Air Force: See Commercial Power, Uninterruptible Power Supply, and Backup Power, in AF T.O. 31Z-822-2, Chapter 1. See Grounding, Bonding Shielding and Lightning Protection requirements in AF T.O. 31Z-822-2, Chapter 2.

### 4-4.6.1 Emergency Electrical Power.

ILS equipment is supplied with backup battery power. No emergency generator is required. Backup power is not required for the FFM.

### 4-4.6.2 Lighting.

No site lighting is required. Obstruction lighting is provided with the equipment.

### 4-4.7 Communications.

Provide a minimum 12-strand single-mode fiber optic cable to each system (elevation and azimuth) through underground conduits and handholes.

Air Force: See fiber optic cable and modem requirements in AF T.O. 31Z-822-2, Chapter 4.

### 4-4.8 Connection/Interrelation to other Facilities.

Each ILS system must be connected to the remote monitoring site (usually the Air Traffic Control Tower) with fiber optic cables.

**Figure 4-13 ILS Facility: Site Plan**

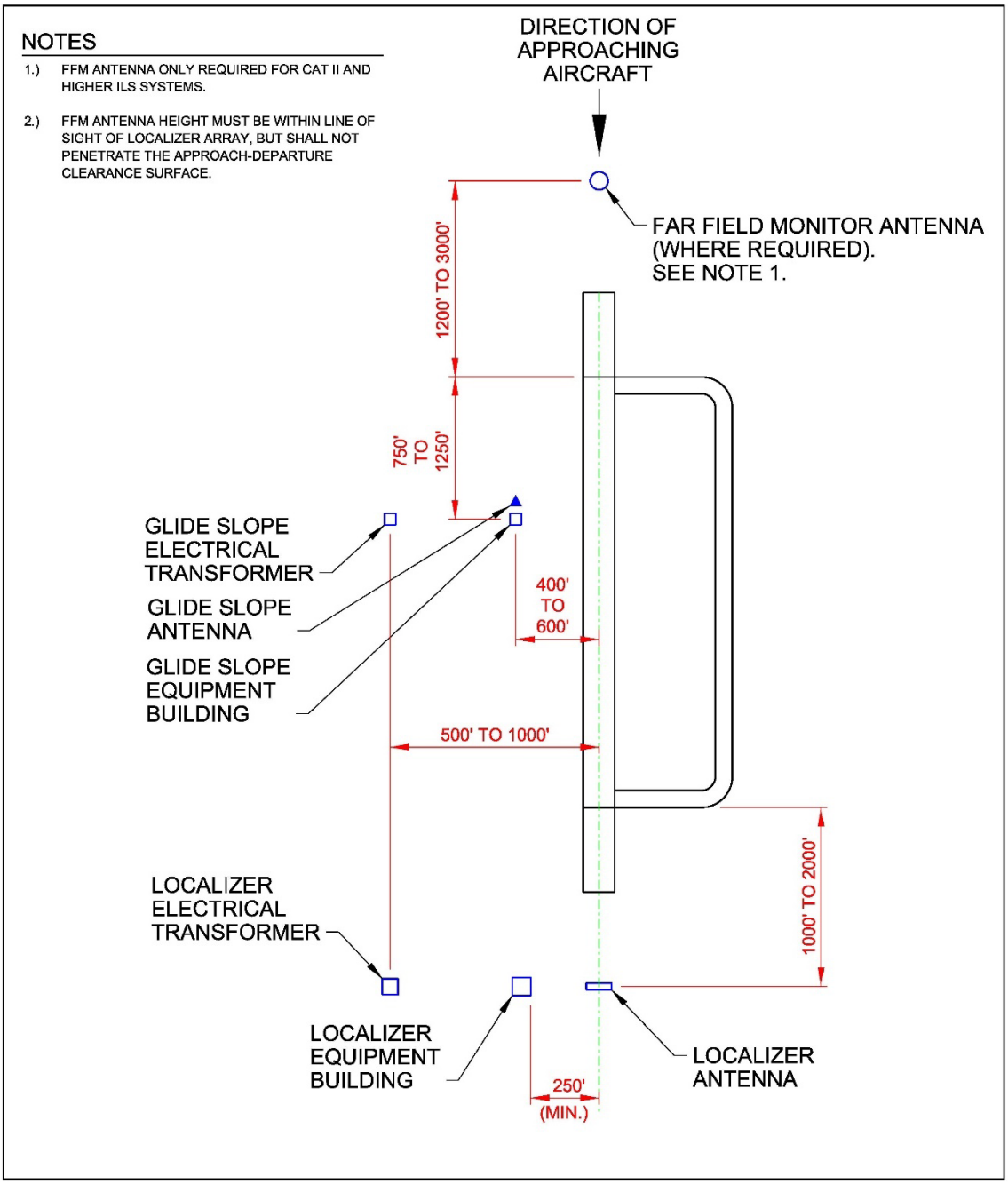
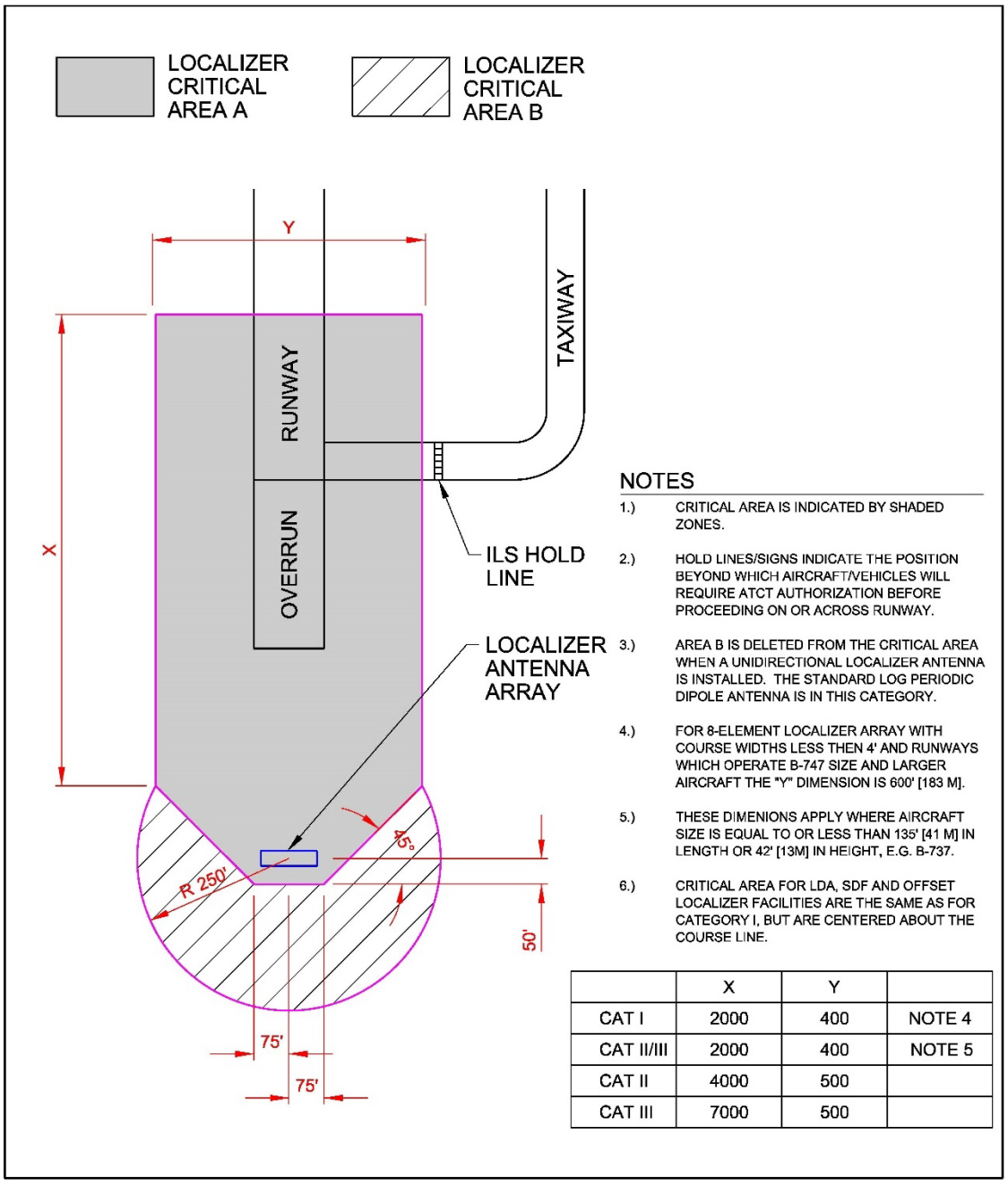


**Figure 4-14 ILS Facility: Localizer Antenna Siting and Critical Area**




NOTES

1.) CRITICAL AREA IS INDICATED BY SHADED ZONES.

2.) HOLD LINES/SIGNS INDICATE THE POSITION BEYOND WHICH AIRCRAFT/VEHICLES WILL REQUIRE ATCT AUTHORIZATION BEFORE PROCEEDING ON OR ACROSS RUNWAY.

3.) AREA B IS DELETED FROM THE CRITICAL AREA WHEN A UNIDIRECTIONAL LOCALIZER ANTENNA IS INSTALLED. THE STANDARD LOG PERIODIC DIPOLE ANTENNA IS IN THIS CATEGORY.

4.) FOR 8-ELEMENT LOCALIZER ARRAY WITH COURSE WIDTHS LESS THEN 4' AND RUNWAYS WHICH OPERATE B-747 SIZE AND LARGER AIRCRAFT THE "Y" DIMENSION IS 600' [183 M].

5.) THESE DIMENIONS APPLY WHERE AIRCRAFT SIZE IS EQUAL TO OR LESS THAN 135' [41 M] IN LENGTH OR 42' [13M] IN HEIGHT, E.G. B-737.

6.) CRITICAL AREA FOR LDA, SDF AND OFFSET LOCALIZER FACILITIES ARE THE SAME AS FOR CATEGORY I, BUT ARE CENTERED ABOUT THE COURSE LINE.

| | X | Y | |
|---|---|---|---|
| CAT I | 2000 | 400 | NOTE 4 |
| CAT II/III | 2000 | 400 | NOTE 5 |
| CAT II | 4000 | 500 | |
| CAT III | 7000 | 500 | |

**Figure 4-15 ILS Facility: Glide Slope Antenna Siting and Critical Area**

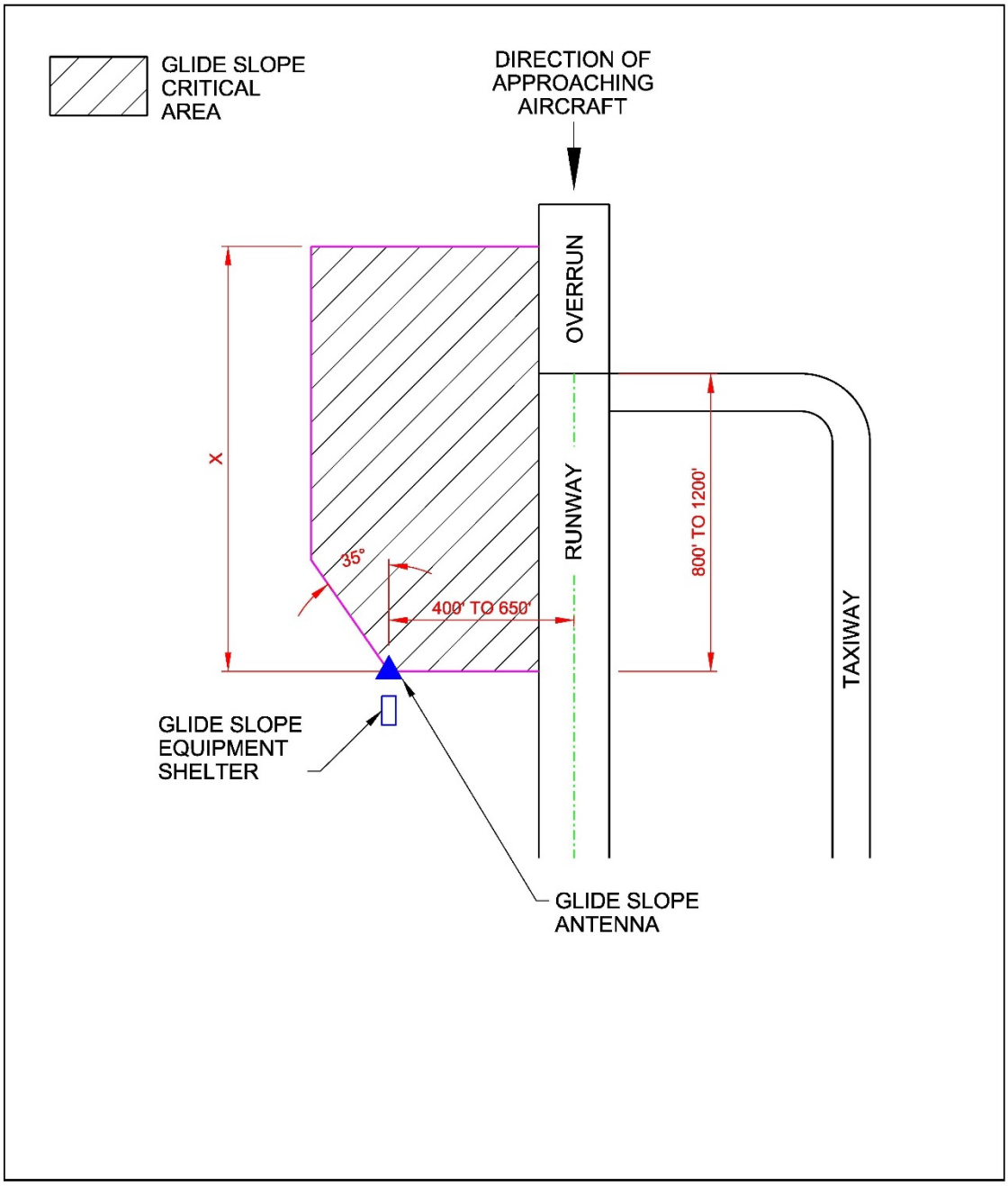


**Figure 4-16 ILS Localizer Equipment and Antenna Site Plan**

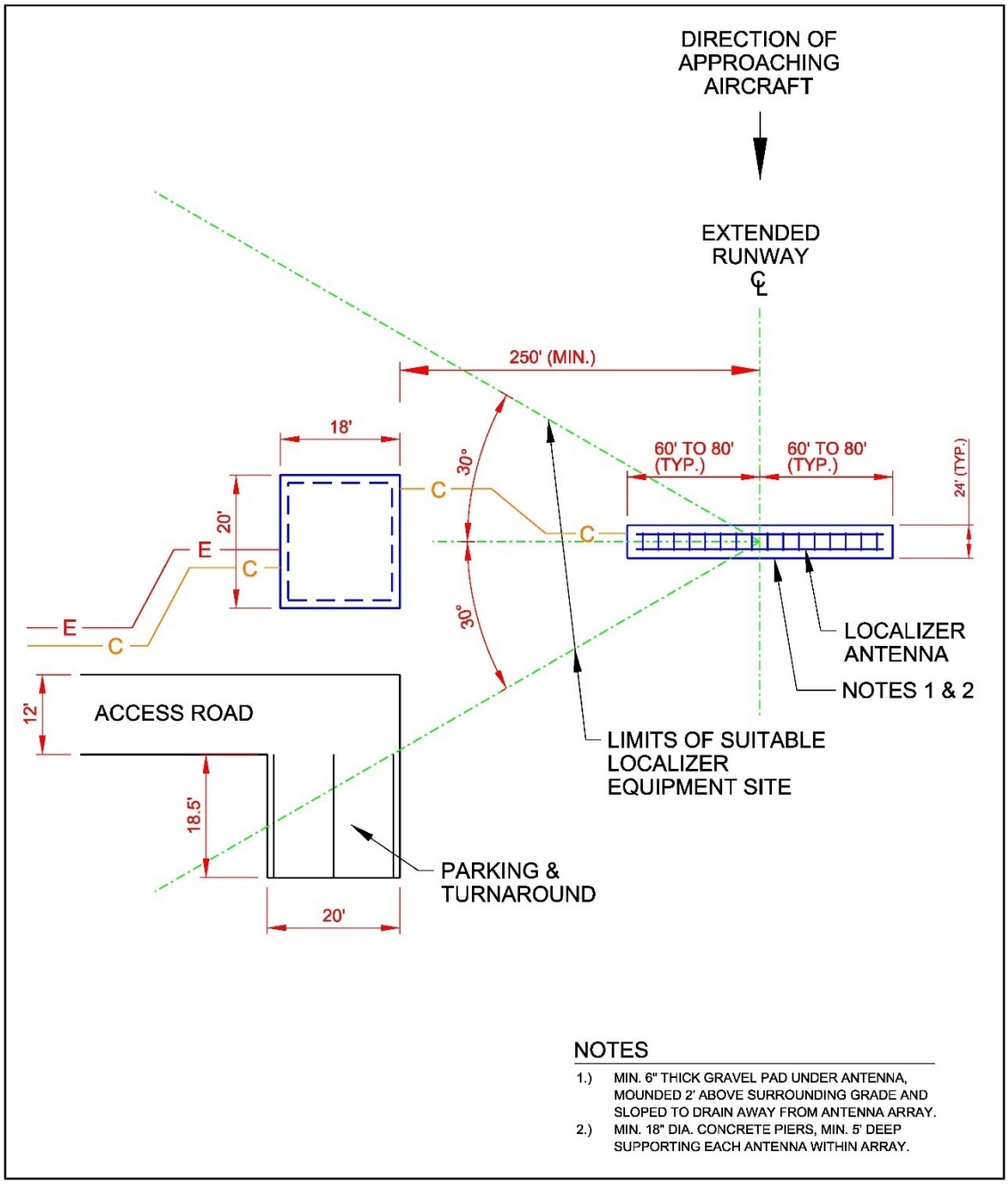
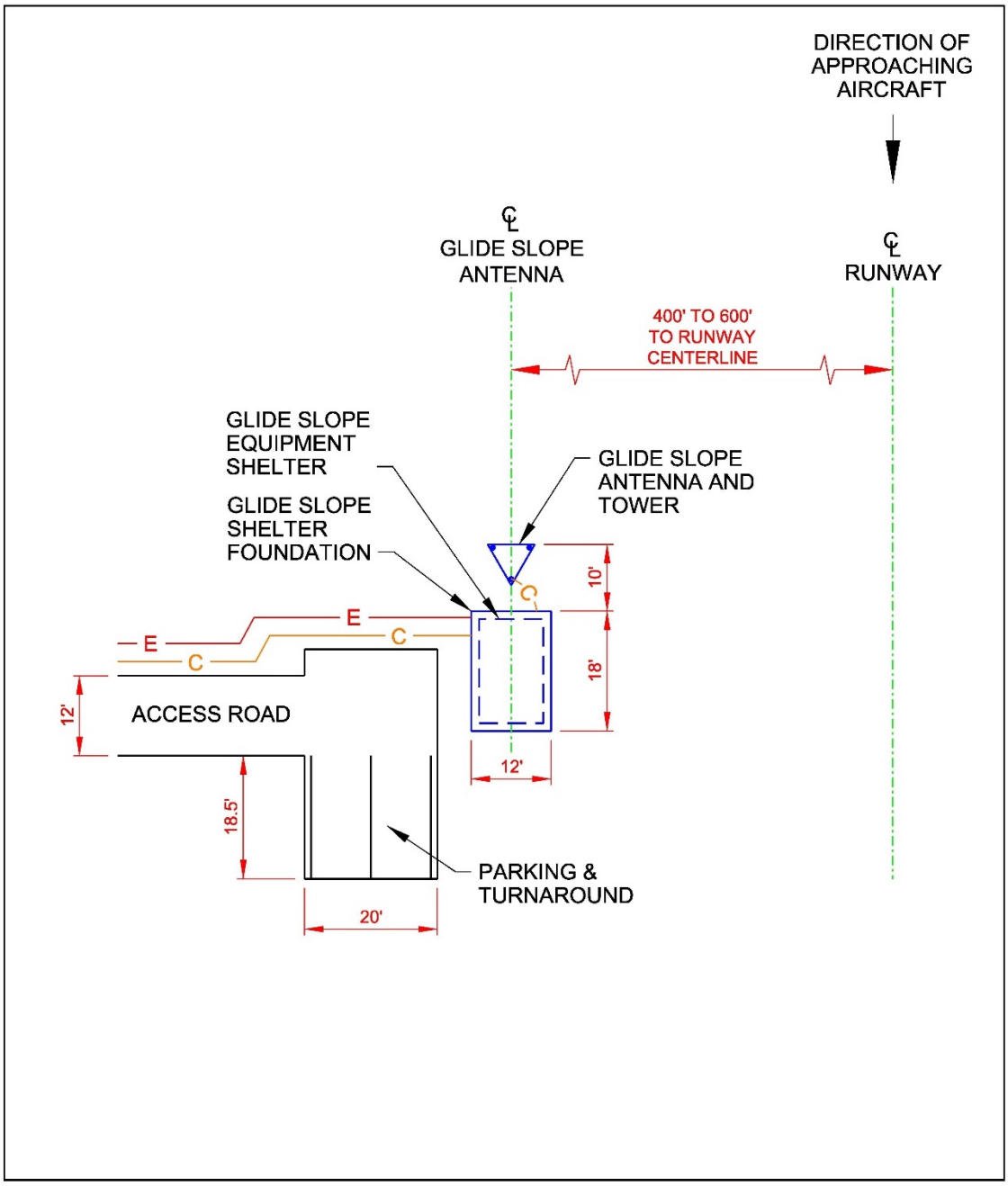


**Figure 4-17 ILS Glide Slope Equipment and Antenna Site Plan**



## 4-5 PRECISION APPROACH RADAR (PAR).

### 4-5.1 Key Documents.

| | |
|---|---|
| UFC 3-260-01 | *Airfield and Heliport Planning and Design* |
| UFC 3-301-01 | *Structural Engineering* |
| AF T.O. 31Z3-822-2 | *Air Traffic Control Landing Systems (ATCALS) Site Requirements 404L* |
| AF T.O. 31P5-2GPN22-12 | *Facility Manual – Radar Set Group, Type AN/GPN-22(V)* |
| SSC PAC PAR SPSPP | *SPAWARSYSCEN Pacific (SSC PAC) Precision Approach Radar (PAR) Site Preparation Standard Plan Package* |

### 4-5.2 Siting.

#### 4-5.2.1 Navy PAR Siting.

Locate PAR sites adjacent to the instrumented runway or runway intersection. See the SSC PAC PAR Site Preparation Standard Plan Package for additional information.

#### 4-5.2.2 Army and Air Force Siting for GPM-22 PAR.

PAR systems (AN/GPN-22) must be sited not less than 512 feet (156 meters) from the centerline of a runway to the near edge of the equipment. The reference reflector must be positioned so that the reflector and the radar antenna are parallel with the runway centerline (± 0.005°), be in clear and unobstructed view of the radar antenna and be located in an area where there are no large reflecting objects. Specific siting criteria for this system is provided in AF T.O. 31P5-2GPN22-12. When it is necessary to place units between parallel runways with insufficient distance to allow a 512-foot (156-meter) clearance to each runway centerline, site the system to provide the minimum distance to the centerline of the primary instrument runway and the lesser clearance to the centerline of the other runway. While it is desirable, from a safety standpoint, to keep these units as low as possible, AFFSA ATCALS will determine the final elevation for the units. The elevation is dependent on the necessary lines of sight between the unit and calibration reflectors and the touchdown areas of the runways. If it is necessary to change the existing ground elevation to provide a proper height for these units, follow grading requirements discussed in UFC 3-260-01, Chapter 3. These systems are non-frangible.

#### 4-5.2.3 AN/FPN-67 or FBPAR (Fixed Base Precision Approach Radar).

The AN/FPN-67 is a modern, solid-state, reliable, ground-based, precision approach radar in a fixed-shelter (or integrated with the ATNAVICS system). AN/FPN-67 systems

must be sited not less than 512 feet (156 meters) from the centerline of a runway to the near edge of the equipment.

### 4-5.2.4 PAR Reflectors (Frangible and Non-Frangible).

#### 4-5.2.4.1 Air Force.

Site moving target indicator (MTI) reflectors, or “target simulators,” not less than 150 feet (46 meters) from the near edge of a runway nor less than 125 feet (38 meters) from the near edge of a taxiway or apron boundary marking to the centerline of the equipment. The height of these reflectors must be held to a minimum consistent with the operational requirements of the system. MTI reflectors sited less than 500 feet (152 meters) from the centerline of any runway must be of frangible construction, using breakaway sections in reflector masts. Tracking reference reflectors must not be installed closer than 500 feet (152 meters) to the centerline of any runway, nor exceed 60 feet (18 meters) in height above the centerline elevation of the nearest runway at the intersection of the equipment centerline perpendicular with the runway centerline.

#### 4-5.2.4.2 Army.

Site MTI reflectors not less than 250 feet (76 meters) from the near edge of a runway nor less than 125 feet (38 meters) from the near edge of a taxiway or apron boundary marking to the centerline of the equipment.

### 4-5.2.5 Airborne Radar Approach Reflectors (Non-Frangible).

Place airborne radar approach reflectors not less than 325 feet (99 meters) from the runway edge and not less than 400 feet (122 meters) nor more than 750 feet (229 meters) from the runway centerline to the edge of the equipment in a pattern parallel to the runway.

#### 4-5.2.5.1 Army.

Locate at least one reflector within the AN/FPN67/AN/TPN-31 PAR azimuth angle coverage area in order to provide a horizontal reference point. Reflectors may not be sited less than 150 feet (46 meters) from the near edge of a runway nor less than 125 feet (38 meters) from the near edge of a taxiway or apron boundary marking to the centerline of the equipment. Reflectors sited less than 250 feet (76 meters) from the runway centerline must be of frangible construction, using breakaway sections of reflector masts, nor exceed 10 feet (3 meters) in height above the centerline elevation of the nearest runway at the intersection of the equipment centerline perpendicular with the runway centerline.

## 4-5.3 Security.

PAR facilities are normally located within the airfield restricted area which typically meets the minimum security measures for external security. When the facility is located within a restricted area of a lower level of security or is located remote and outside of an

established restricted area, provide additional measures to meet the minimum level of security assigned to the facility.

### 4-5.4 Facility Design Guidance.

#### 4-5.4.1 Site Work.

Provide a roadway to allow access to the PAR system. Provide parking space for two maintenance vehicles. Include access roads located around the COTS PAR concrete pad and from any nearby access road. See Chapter 2, paragraph “Access and Parking” for roadway and parking area design requirements. The use of asphalt pavement for access routes is not allowed. Slope the access roads and concrete pads to provide positive drainage away from the COTS PAR equipment and toward any stormwater management facility or existing vegetation.

Provide a reinforced concrete pad approximately 20' x 40’ (6 x 12 m) to accommodate the main PAR facility equipment. A site-specific concrete pad may be installed to accommodate a generator, transformer, or fuel tank. Install additional concrete pads to accommodate reflector towers and guy wire anchor pads. The number of reflector towers required is site specific.

#### 4-5.4.2 Architectural Requirements.

There are no architectural requirements for the PAR. The building is a prefabricated shelter.

#### 4-5.4.3 Structural Requirements.

The PAR system is housed in a transportable shelter provided by the system manufacturer. Provide a reinforced concrete pad for the fixed mounted PAR and reinforced concrete foundations to support the turntable-mounted PAR frame. Provide concrete anchor blocks for turntable stop anchor bolts.

##### 4-5.4.3.1 Design Criteria and Loads.

Base the structural design on a Risk Category of IV, as noted in UFC 3-301-01, Structural Engineering, Table 2-2. See the SSC PAC PAR SPSPP for additional structural design criteria.

Place the PAR and associated infrastructure on a minimum 6-inch (150 mm) thick 40’ x 20’ (12 m x 6 m) concrete slab on grade. Provide a slab with a thickened footing at the edge with a minimum embedment below the finished grade of 12 inches (300 mm). Provide a thickened footing at the edge a minimum of 15 inches (380 mm) thick and 12 inches (300 mm) wide. Adjust the dimensions of this footing based on the frost depth penetration at each site and based on the findings of the site-specific geotechnical investigation.

Place the PAR Sensor on a 4-ft (1.2 m) tall, 6’ x 6’ (1.8 m x 1.8 m) cast-in-place concrete pedestal. Support the cast-in-place concrete pedestal with a foundation of variable size, designed based on the wind category applicable to the facility location. Install the Antenna Mounting assembly within the concrete pedestal. This assembly consists of two mounting plates and 12 anchor bolts, nuts, and washers.

### 4-5.5 Mechanical Requirements.

Air Force: See Environmental Control Unit requirements (e.g., allowable temperature and humidity ranges) in AF T.O. 31Z3-822-2, Chapter 3.

### 4-5.6 Electrical Power.

To avoid potential interference with antenna transmissions, install power, communications, and control cables underground within 1,000 ft (305 m) of the PAR facility. Ensure electrical systems do not interfere with radio and radar transmissions.

Provide commercial power service to the PAR. Provide service maximum 25kVA, 208Y/120V, 3 Phase, 4-wire, 60Hz.

Provide the PAR site with a new 100-amp electrical panelboard: 208Y/120V, 3 Phase, 4-wire, 60Hz. Provide a panelboard with a 100A, 3-Pole, ground fault protected main circuit breaker. Mount the panelboard on two concrete imbedded stainless steel channel stanchions, minimum 5 feet exposed above grade. Install the panelboard at a location aligned with the corner of the PAR power/electronics equipment shelter where the enclosure-provided disconnect is positioned.

Air Force: See Commercial Power, Uninterruptible Power Supply, and Backup Power, in AF T.O. 31Z-822-2, Chapter 1. See Grounding, Bonding Shielding and Lightning Protection requirements in AF T.O. 31Z-822-2, Chapter 2.

#### 4-5.6.1 Emergency Electrical Power.

Provide a backup power generator, minimum 30 kVA. See Chapter 2 for additional requirements.

#### 4-5.6.2 Grounding and Bonding.

Install four perimeter ground rods with an interconnecting below grade #2/0 Bare Copper ground conductor. Install one of the corner ground rod locations in a round test handhole with H20 traffic rated cover. Place the ground loop 6.5 feet from the edge of the PAR Site concrete pad. Bond the grounding systems for the generator and transformer below grade to the ground loop. Install a 12' x 12' (3.7 m x 3.7 m) copper ground mesh 2 feet below grade between the PAR power/electronics shelter and the PAR Sensor. Install three additional ground rods in a triangular pattern with the tops exposed, bonded to the mesh, the perimeter ground loop, and bonded together above grade. Connect two of the exposed ground rods to the PAR power/electronics shelter and the PAR Sensor. Connect the third exposed ground rod below grade to the

electrical panelboard ground bus and a communication termination box ground bus. Configure the placement of the three triangular pattern grounds to allow for installation of an above ground cable tray between the power/electronics shelter and the PAR Sensor.

Install a separate isolated ground rod exposed a minimum of 6 inches (15 cm) above grade at a maximum distance of 1 foot (31 cm) from the edge of the concrete pad to support connection from a lightning protection tower cable.

The ground impedance at all locations of the grounding system must not exceed 10 ohms. Ideal ground impedance is less than 1 ohm.

#### 4-5.6.3 Lighting.

No site lighting is required. Obstruction lighting is provided with the equipment.

### 4-5.7 Communications.

Provide a minimum 12-strand single-mode fiber optic cable to each system (elevation and azimuth) through underground conduits and handholes.

Air Force: See fiber optic cable and modem requirements in AF T.O. 31Z-822-2, Chapter 4.

### 4-5.8 Connection/Interrelation to other Facilities.

The PAR system must be connected to the remote monitoring site (usually the Air Traffic Control Tower) with fiber optic cables.

**Figure 4-18 PAR Facility Siting Criteria**

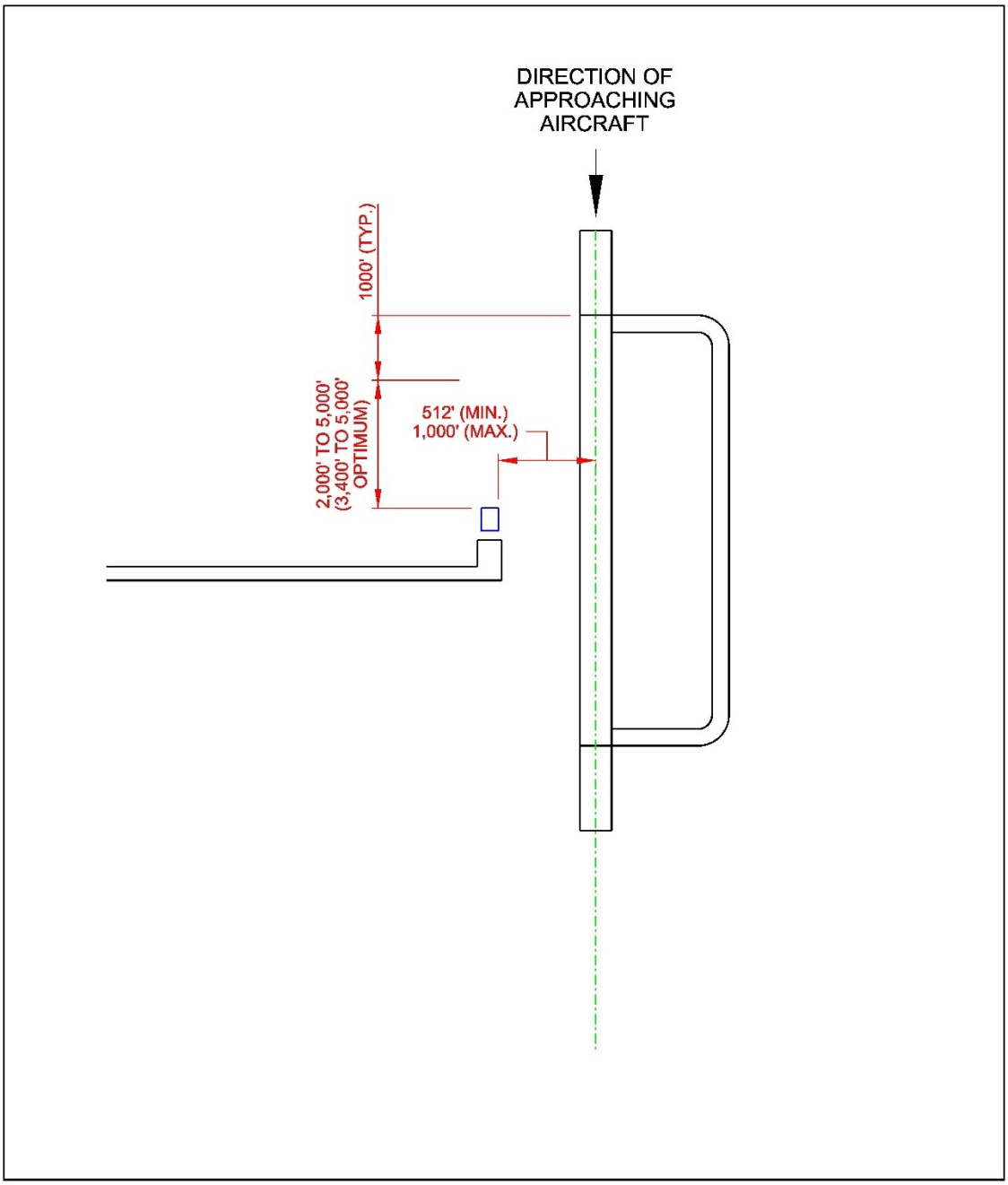


**Figure 4-19 PAR Facility Site Plan**

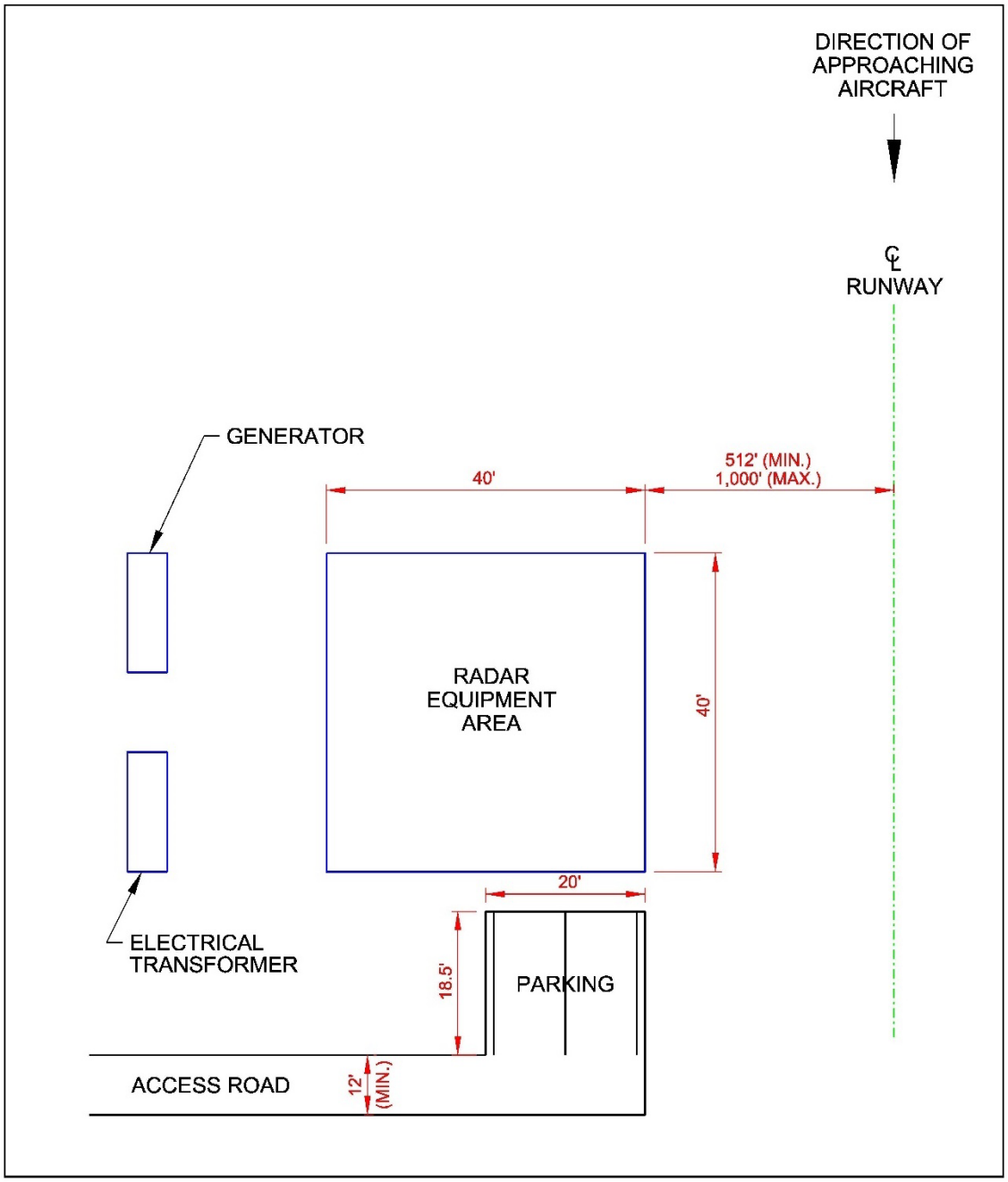


**Figure 4-20 PAR Facility: Turntable Mounted Radar Plan and Elevation**

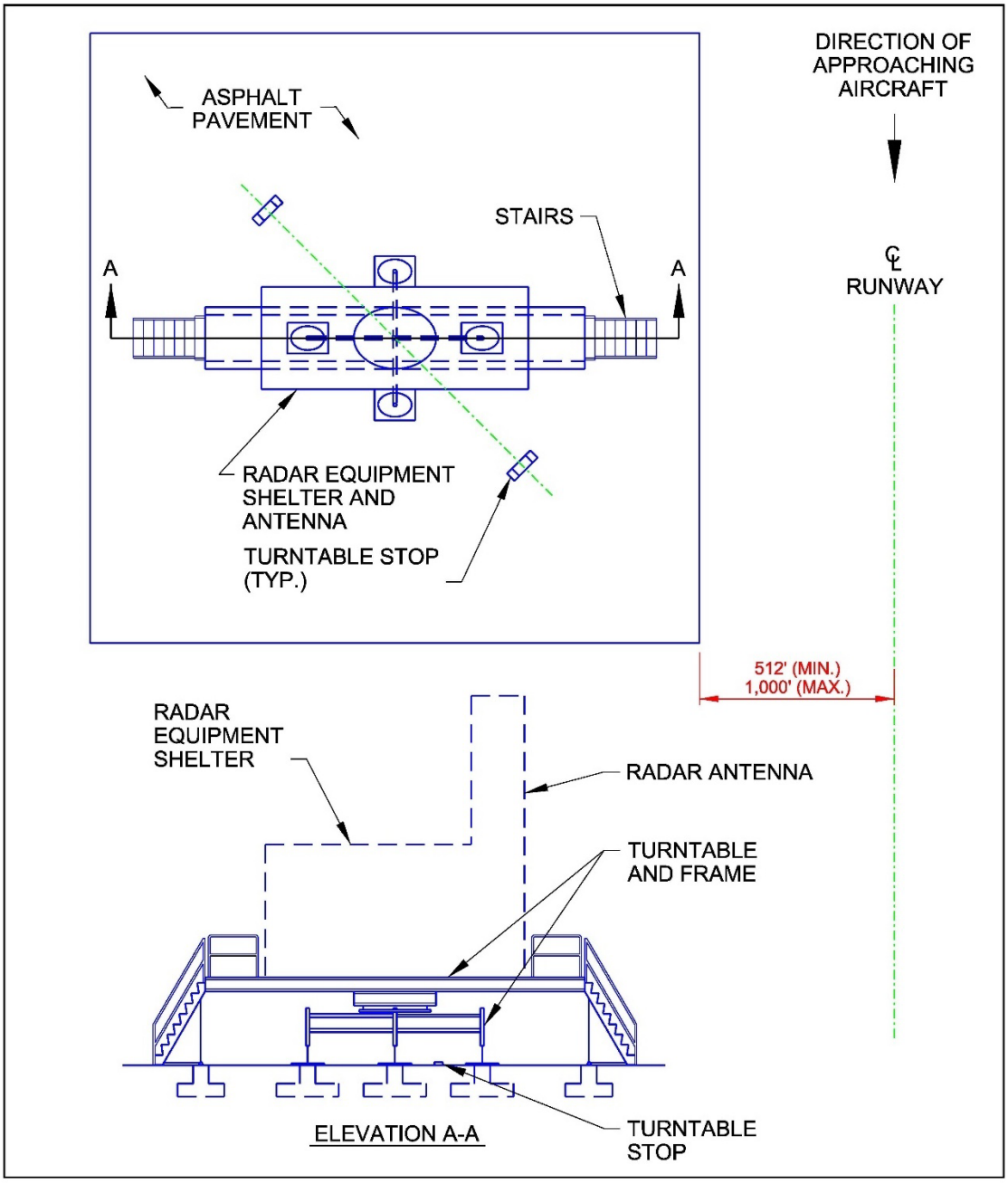
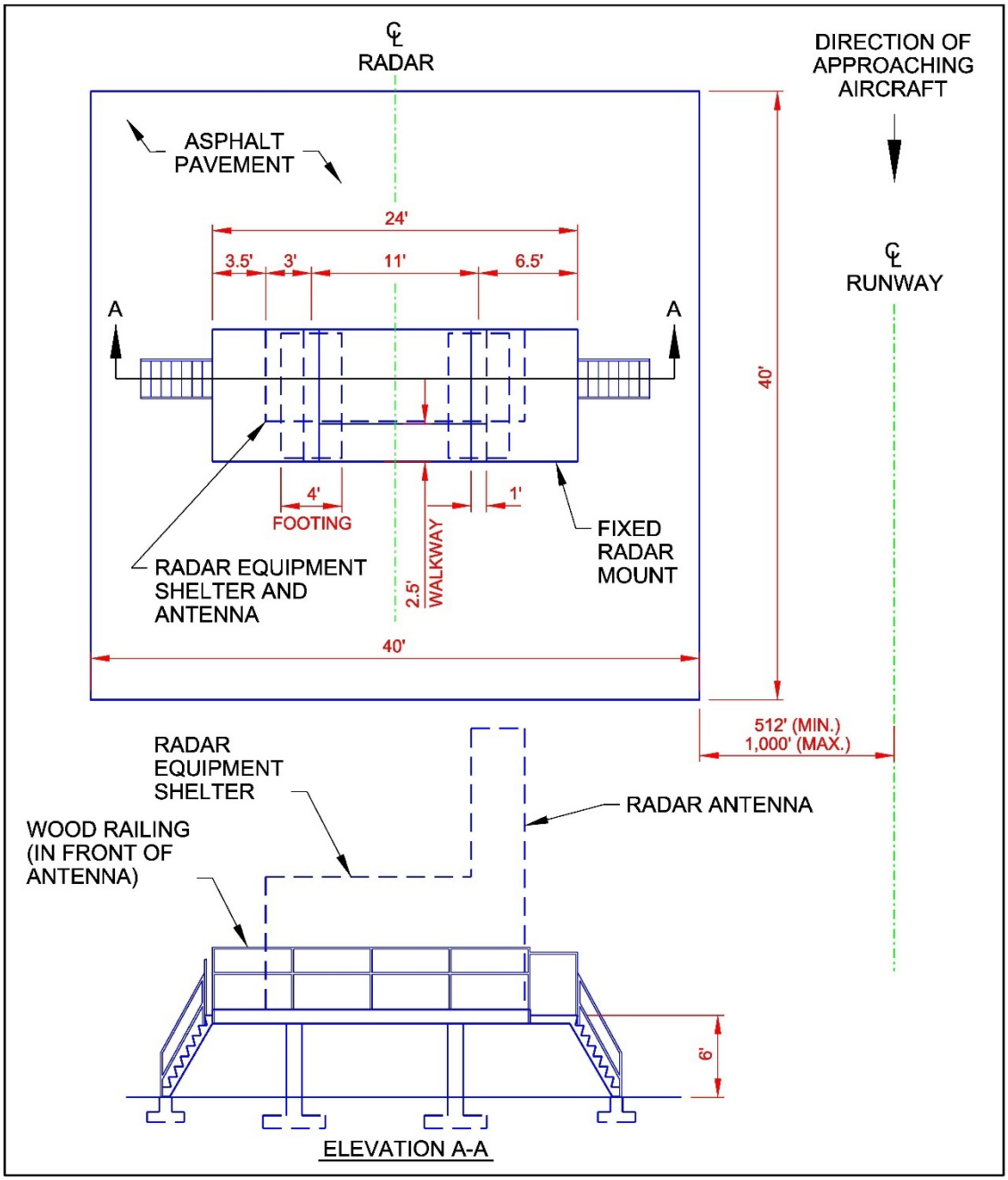


**Figure 4-21 PAR Facility: Fixed Mounted Radar Plan and Elevation**



# CHAPTER 5 AIR SURVEILLANCE RADAR SYSTEMS

## 5-1 GENERAL INFORMATION.

### 5-1.1 Function.

Air Surveillance Radar (ASR) facility buildings provide housing for electronic radar equipment used to detect and display location information about in-flight aircraft. These facilities are unattended.

#### 5-1.1.1 Air Surveillance Radar (ASR).

The ASR is an electronic radar system used to obtain the range and azimuth of an aircraft. When equipped with an Air Traffic Control Radar Beacon System (ATCRBS), the ASR obtains altitude and azimuth of an aircraft. When equipped with an ATCRBS, the ASR obtains altitude and identification of the aircraft. Information obtained by the ASR and ATCRBS is displayed in the Military Terminal Radar Approach Control Facility (MTRACON), the air traffic control tower with ground-controlled approach or a Joint Control Facility (JCF). The ASR is used to control aircraft on overflight, approach, and departure flight paths at a terminal facility. Figures 5-1 through 5-3 show a typical ASR.

#### 5-1.1.2 Air Route Surveillance Radar (ARSR).

The ARSR is an electronic radar system used to obtain the range and azimuth of an aircraft. These systems are only owned and operated by the FAA, and therefore are not included in this UFC.

**Figure 5-1 Typical Airport Surveillance Radar (ASR) Steel Tower**

**Figure 5-2 Typical Digital Airport Surveillance Radar (DASR) (Army)**

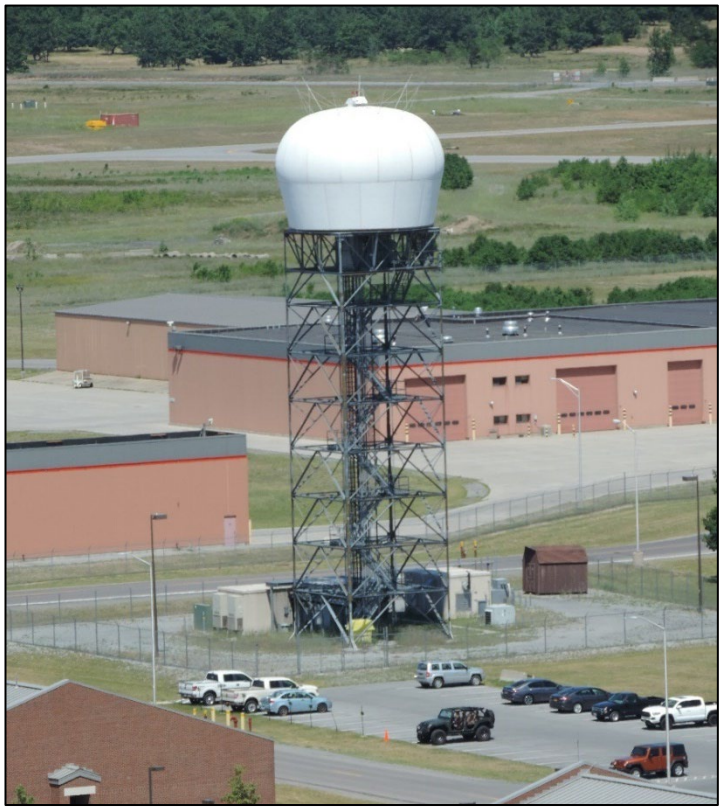


**Figure 5-3 Typical DASR without Antenna Cover (Army)**

## 5-2 AIRPORT SURVEILLANCE RADAR (ASR).

### 5-2.1 Key Documents.

| | |
|---|---|
| FAA Order 6310.6 | *Primary/Secondary Terminal Radar Siting Handbook* |
| FAA Order 6340.15 | *Primary/Secondary En Route Radar Siting Handbook* |
| AF T.O. 31Z3-822-2 | *Air Traffic Control Landing Systems (ATCALS) Site Requirements 404L* |

### 5-2.2 Siting.

Locate the ASR adjacent to the radar facility antenna tower. Locate the ASR facility radar no closer than 0.5 nautical miles from the approach and departure ends of the runway. Do not locate the radar below the approach/departure paths or ground-controlled approach patterns. Care should be exercised in the placement of the ASR in relation to the Air Traffic Control tower as it can create a screening object for the radar. The only limit to the radar's distance from the airfield for ASR approaches is 20 nautical miles as defined in the 8200.1D United States Standard Flight Inspection Manual. This is based upon current radar accuracy to place an aircraft target on a standard runway width. The ASR facility at Range Airspace Surveillance Sites (RASS) may be located further away. Locate the facility to minimize obstruction to radar transmissions. Refer to FAA Order 6310.6 and FAA Order 6340.15. See Figure 5-4 for general siting requirements.

Clearances: Prior to determining final antenna placement, conduct an analysis as part of the site approval process for transmitters of electromagnetic radiation. Electromagnetic Environmental Effects (E3) analysis will determine Hazards to Personnel (HERP), Hazards to Ordinance (HERO), Hazards to Fuel (HERF), and Electromagnetic Interference (EMI).

Produce a Radar Siting Analysis (RSA), using FAA order 6310.6 as a guide, to analyze operational requirements and facilitate final site selection. Radar siting analysis is typically conducted by the Program Office deploying the radar asset in conjunction with the local Air Traffic Control Facilities Officers. ASR antennas may be elevated to obtain line-of-sight clearance. Typical ASRs (antenna platform heights – mezzanine level) range from 17 to 77 feet (5 to 23.5 m) above ground level (AGL). The antenna tower is a standard 24 feet × 24 feet (7 m × 7 m) galvanized steel structure. Additional ten-foot (3 m) sections are usually added incrementally until the radar platform reaches the desired elevation. Trees and other structures must always stay below the mezzanine level. Carefully evaluate the presence of wind turbines in the vicinity of an airport while siting the location of a radar antenna system as such objects do cause reflectivity issues and are the cause of false targets.

### 5-2.3 Security.

Air surveillance radar facilities are normally located within restricted area which typically meets the minimum security measures for external security. When the facility is located within a restricted area of a lower level of security or is located remote and outside of an established restricted area, provide additional measures to meet the minimum security requirements for the level of security assigned to the facility.

### 5-2.4 Facility Design Guidance.

See Figures 5-5 and 5-6 for typical ASR site plan and building layout. See service-specific guidance for allowable building size. Typical building size is 1,400 square feet (130 square meters) to house the electronic equipment, monitoring and test equipment, and mechanical equipment.

#### 5-2.4.1 Site Work.

Provide an access road to allow maintenance vehicles access to the ASR. Provide parking space for four maintenance vehicles. See Chapter 2, paragraph “Access and Parking” for roadway and parking area design requirements.

#### 5-2.4.2 Architectural Requirements.

Provide the following:

- Adequate space for equipment and equipment maintenance.
- Clear ceiling height of 10 feet (3 m).
- Work bench.
- Vinyl tile flooring in equipment room.

Do not provide a restroom.

Do not provide windows.

Consider the use of a premanufactured building.

#### 5-2.4.3 Structural Requirements.

Design roof structural system to support cable trays and radar equipment wave guides.

### 5-2.5 Mechanical Requirements.

Design mechanical systems to meet the general criteria in Chapter 2. Ensure mechanical systems do not interfere with radar transmissions.

Air Force: See Environmental Control Unit requirements (e.g., allowable temperature and humidity ranges) in AF T.O. 31Z3-822-2, Chapter 3.

#### 5-2.5.1.1 Heating.

Provide a minimum temperature of 70 degrees F (21°C).

#### 5-2.5.1.2 Air Conditioning.

Provide two separate air conditioning systems, each capable of handling the entire load independently. One unit functions as a secondary backup unit if the primary unit fails. Provide the following:

- Separate thermostat controls for each unit.
- Interlocked primary and secondary units to prevent simultaneous operation.

### 5-2.6 Electrical Power.

To avoid potential interference with radar transmissions, install power, communications, and control cables underground within 1,000 ft (305 m) of each facility. Ensure electrical systems do not interfere with radio transmissions.

Provide 120/240V, 100A, single-phase, 60 HZ commercial power service to the ASR.

#### 5-2.6.1 Emergency Electrical Power.

Provide an emergency generator with automatic starting and switching capability as described in Chapter 2. Provide emergency power to the entire radar facility.

#### 5-2.6.2 Uninterrupted Power Supply (UPS).

Provide non-redundant UPS in accordance with Chapter 2. Use the anticipated load to determine the size of the UPS.

#### 5-2.6.3 Lighting.

Reserved.

### 5-2.7 Communications.

Provide 12-strand single mode fiber optic cable or 25 twisted pair communications line to provide required connectivity for data and telephone.

- Data connectivity from the ASR to Remote Unit located in the ATC Tower. (Dedicated pair)
- Data connectivity from the ASR Fire Alarm to external monitoring system. (Dedicated pair)
- Telephone line for distance support to troubleshoot system.

Air Force: See fiber optic cable and modem requirements in AF T.O. 31Z-822-2, Chapter 4.

### 5-2.8 Connection/Interrelation to other Facilities.

Connect a dedicated DSN-capable telephone connection through to the ASR to facilitate distant support, troubleshooting, and corrective maintenance due to the remote location. Connect the ASR to the ATC Tower via fiber optic cable for remote monitoring.

**Figure 5-4 ASR Facility Siting Criteria**

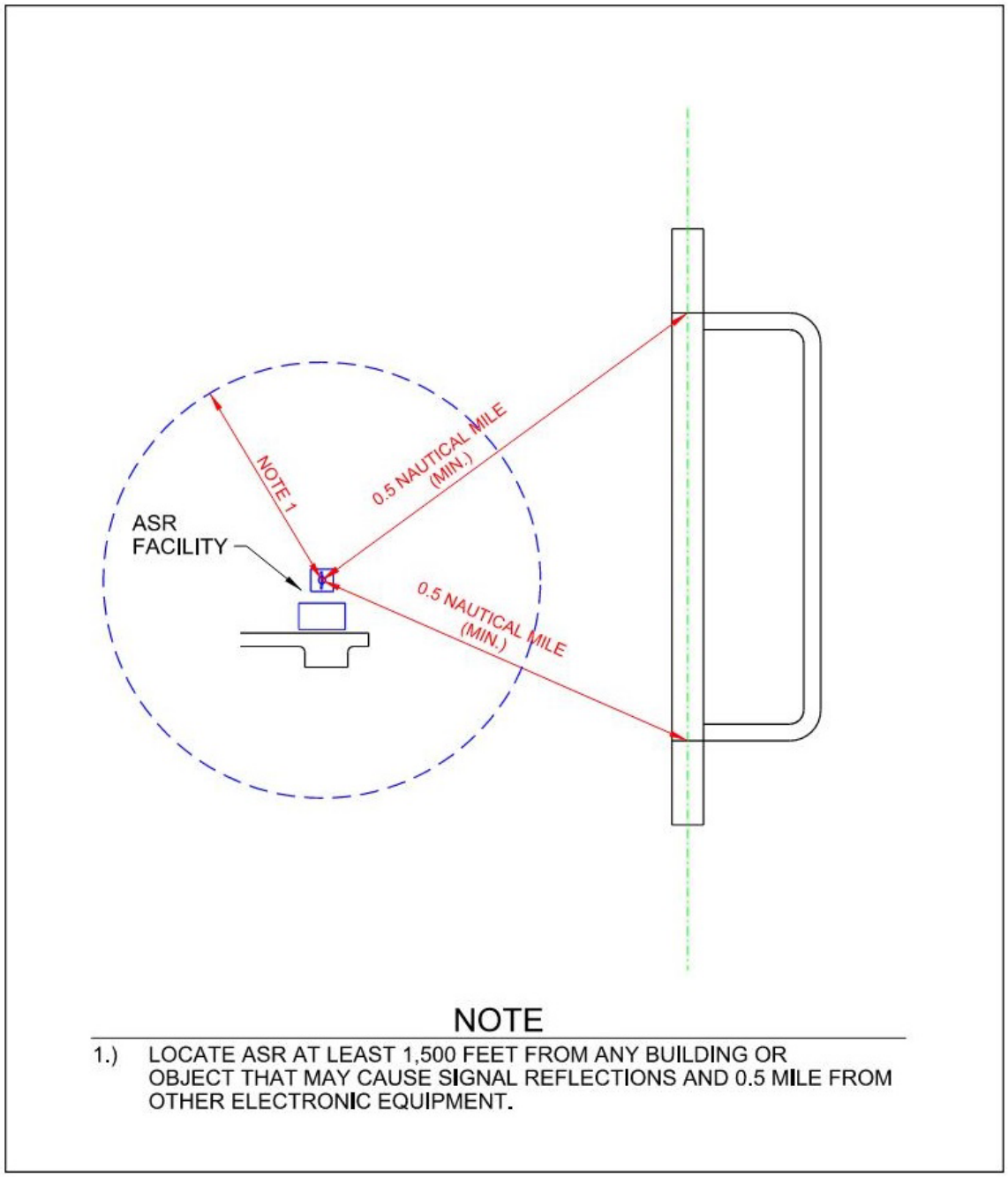


**Figure 5-5 ASR Site Plan**

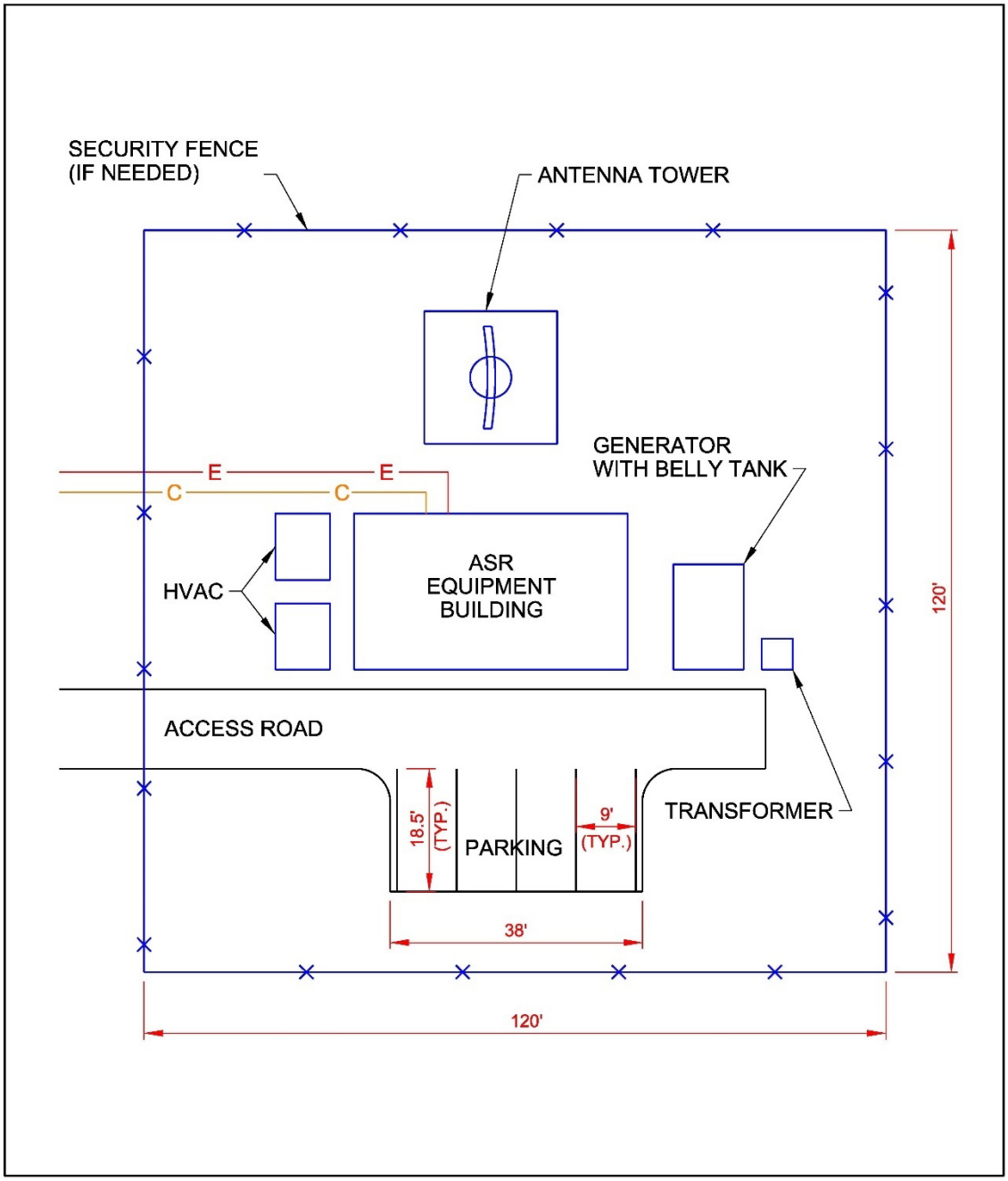
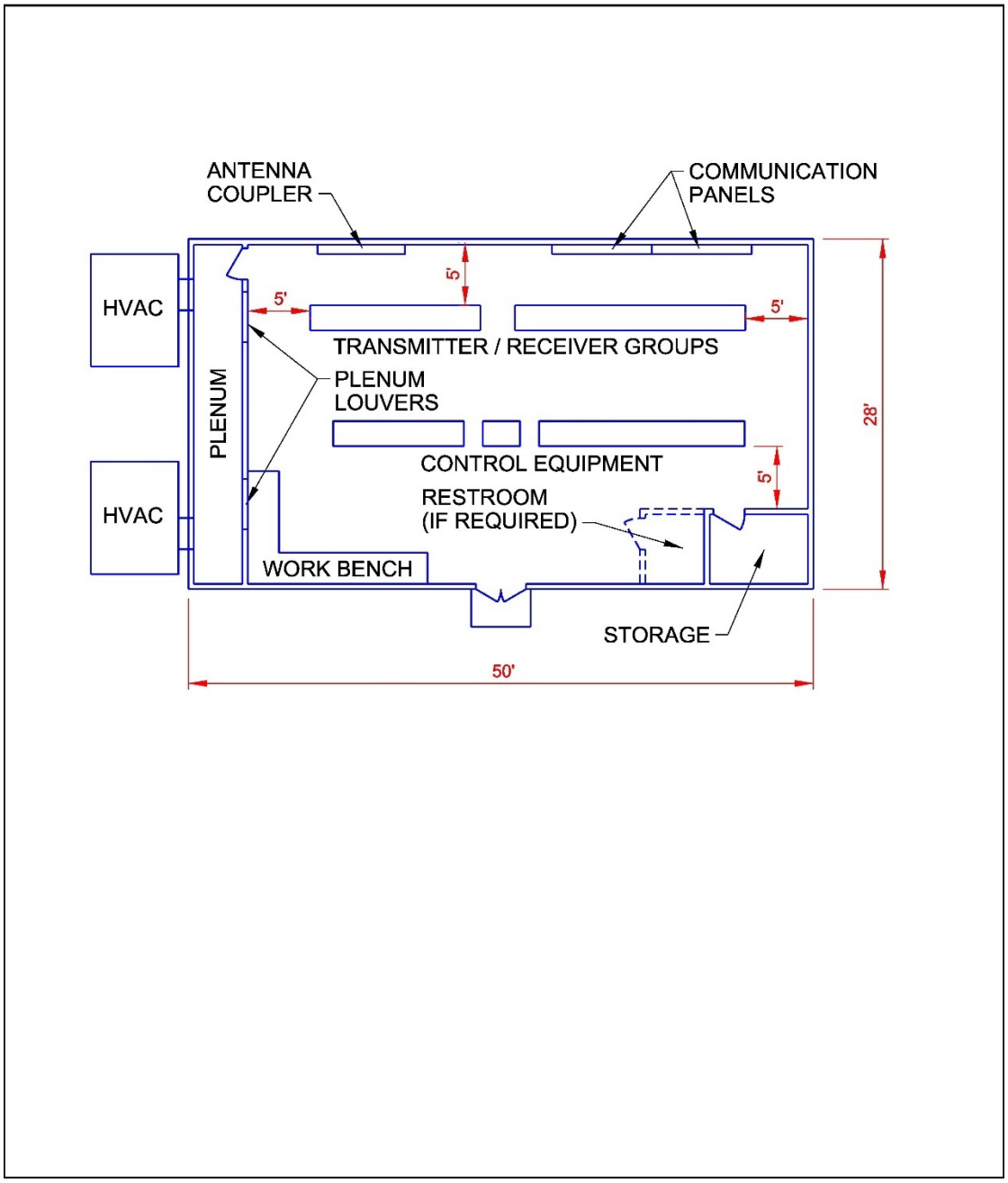


**Figure 5-6 ASR Building Layout**



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# CHAPTER 6 COMMUNICATIONS FACILITIES SUPPORTING AIRFIELDS

## 6-1 GENERAL INFORMATION.

### 6-1.1 Function.

Air Traffic Control (ATC) communications facilities provide environmentally controlled spaces that house radio frequency (RF) Transmitter (Tx) and/or Receiver (Rx) equipment used to communicate with aircraft for ATC operations and for regulating all types of aircraft on an airfield.

ATC communications facilities contain remote electronic communications and linking equipment used for ground-to-air (G/A) communications with tactical and transient aircraft, to control aircraft departures and arrivals, and to communicate with other agencies involved in ATC or aviation support.

There are three types of ATC Communications Facilities:

- Transmitter Facilities (Tx)
- Receiver Facilities (Rx)
- Collocated Transmitter/Receiver (Tx/Rx) Facilities

**Figure 6-1 Remote Transmitter/Receiver (RTR) Communication Facility**

#### 6-1.1.2 Transmitter (Tx) Facility.

The transmitter building contains transmitting equipment, antenna coupling equipment, and maintenance and test equipment.

### 6-1.1.3 Receiver (Rx) Facility.

The receiver building contains receiver and repeater equipment, antenna coupling equipment, and maintenance and test equipment.

### 6-1.1.4 Collocated Transmitter and Receiver (Tx/Rx) Facility.

The collocated Rx/Tx facility contains both Rx and Tx equipment, antenna coupling equipment, and maintenance and test equipment.

### 6-1.1.5 Remote Data Link Building.

The remote data link building provides housing for a suite of communications linking equipment. Equipment suites typically include satellite communications, radio, and television microwave.

### 6-1.1.6 Continuity of Operations.

#### 6-1.1.6.1 Coordination

Normal air traffic control (ATC) operations may be affected by construction, renovation, and/or repair of the ATC communications facility. Give careful consideration to the operational impact of a proposed facility design/specification; the goal is to minimize these impacts. Coordinate any design that results in construction that has the potential to affect safety of flight (SOF) with the Airfield Manager. Coordinate any construction that affects structures currently housing electronic equipment required to support air operations through each Service’s subject matter expert.

#### 6-1.1.6.2 Temporary Facilities

If existing facility demolition or repair efforts are required prior to construction of the new ATC communications facility, demolition/repair efforts must not start until all communications functions have been fully transferred to a temporary facility and the temporary facility has been certified fully operational by the Air Traffic Control function. This stipulation is vital to maintaining ATC operations and SOF.

## 6-2 ATC COMMUNICATIONS FACILITY.

Whether constructing a Tx, Rx or collocated Tx/Rx facility, the components and requirements are the same, with the exception of the space required for a collocated facility. Collocated facilities require more space inside the building to house additional radio equipment and may require more parking space outside the facility.

### 6-2.1 Key Documents.

| | |
|---|---|
| UFC 3-260-01 | *Airfield and Heliport Planning and Design* |
| UFC 3-301-01 | *Structural Engineering* |
| UFC 3-600-01 | *Fire Protection Engineering for Facilities* |
| UFC 4-133-01 | *Air Traffic Control and Air Operations Facilities* |
| NAVAIR 01-1A-23 | *Standard Maintenance Practices Miniature/Microminiature (2M) Electronic Assembly Repair* |
| NAVSEA OP 3565, Vol. 2 | *Electromagnetic Radiation Hazards* |
| N65236-ATCF-FRD-0003 v2.0 | *NIWC - Air Traffic Control Remote Communications Facility – Facility Requirements Document* |
| NAVFACINST 11010.45A | *Site Approval Request Process* |
| FAA Order 6580.2 | *Remote Communications Facility Siting Criteria Handbook* |
| FAA Order 6580.3B | *Remote Communications Facilities Installation Standards Handbook* (not accessible outside FAA) |
| FAA Order 6580.6A | *Remote Communications Facilities Siting Process* (not accessible outside FAA) |
| FAA-STD-019f | *FAA Standard, Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities* |
| AF T.O. 31Z3-822-2 | *Air Traffic Control Landing Systems (ATCALS) Site Requirements 404L* |

### 6-2.2 Siting.

Locate radio communications buildings within the antenna field to provide minimum length of cable from antenna to radio communications equipment. Refer to the Base Master Plan and consider planned expansion of airfield systems when locating communications facilities. See FAA Order 6580.2 for additional details. Figure 6-2 illustrates general siting requirements.

#### 6-2.2.1 Site Selection.

a. Use a coordinated effort between Air Operations, Air Traffic Control, and the service-specific engineering and equipment maintenance organizations to select potential facility sites. Site selection must consider the requirements listed in this document, UFC 3-260-01, and current service-specific publications.

b. Select construction sites to account for an antenna field next to or surrounding the ATC communications facility. The facility's antenna field typically has up to 10 antenna towers, with six to eight antennas on each tower. A minimum separation of 80 feet (24 m) is required between antenna towers; a separation of 120 feet (37 m) is preferred. See Figure 6-3 for a typical ATC communications facility site plan. See Figure 6-5 for a typical antenna tower. Towers can be a maximum of 350 feet (107 m) from the ATC communications facility.

c. The size (diameter) of the RF cable is dependent on the total length of the cable path from the antennas to the radios. Determine the exact RF cable diameter during design. Note: The diameter of RF cable can be as large as 1-5/8". Typically, 7/8" (22 mm) cable is used for exterior runs exceeding 100 ft (30 m).

d. Antennas mounted on towers require an unobstructed Line of Sight (LOS) to all runways, taxiways, ramps, and parking aprons. The service-specific electronics maintenance office (e.g., NIWC Atlantic) is required to perform an RF coverage/propagation analysis to select the optimal site locations to ensure the locations and tower heights provide operational coverage for ATC communications.

#### 6-2.2.2 Radiation Hazards

Hazards of Electromagnetic Radiation to Personnel (HERP), Ordnance (HERO), and Fuel (HERF) surveys are crucial to the siting process. Contact service-specific offices to conduct these surveys (e.g., NIWC Atlantic, NSWC Dahlgren Division, etc.) NIWC Atlantic and the facility Air Operations Department can assist with information concerning the electronic equipment to be installed in the facility to support ATC operations. Radiating RF antennas are installed on the antenna towers; therefore, a radiation hazard (RADHAZ) study to support the antenna installation must be conducted during the siting process. Facility siting criteria must consider the radiating fields of existing antennas supporting ATC operations, such as the Airport Surveillance Radar

(ASR). NAVSEA OP 3565, Vol. 2 provides detailed information concerning HERP, HERO, and HERF.

### 6-2.2.3 Site Approval.

Navy: Final site approval must comply with current NAVFACINST 11010.45A requirements.

### 6-2.3 Security.

Communications facilities are normally located within restricted areas which would typically meet the minimum security measures for external security. When the facility is located within a restricted area of a lower level of security or is located remote and outside of an established restricted area, provide additional measures to meet the minimum security requirements for the level of security assigned to the facility.

### 6-2.3.1 Fencing

Chain link fences are required around the facility and antenna tower field. Provide fences 8 ft. high and include three strands of barbed wire at the top. Ground all fences in accordance with FAA STD-19f. Provide one motorized or manual vehicle gate and one personnel gate. Determine the exact locations of these items during the design process.

Note: A minimum distance of 30 ft (9 m). is required between the communications building and the fence on all sides.

### 6-2.4 Facility Design Guidance.

### 6-2.4.1 General.

**6-2.4.1.1** This section is divided into engineering disciplines associated with the design effort in order to consolidate requirements and simplify distribution. Designers for each discipline must consult with each other to verify that design conflicts do not exist and that all aspects of the design support a suitable final product.

**6-2.4.1.2** Tx and Rx buildings are composed of interlaced engineered systems. The design of the facility does not lend itself to late involvement by engineering disciplines (e.g., mechanical and electrical). All engineering disciplines must be actively involved during floor plan inception. At the 35% design submittal, develop all engineered facility systems that affect ATC communications equipment to a level such that the minimum required square footages identified in the FRS are assured.

6-2.4.1.3 Contact Service-specific agencies (e.g., NIWC Atlantic) to obtain drawings of the electronic equipment cabinet layout during the design process. See Figure 6-3 for a typical layout of facility equipment.

**6-2.4.1.4** Paragraphs in this section identify requirements to support electronic equipment or construction recommendations for general use. Specific details of some requirements identified in this section must be obtained from the facility Air Operations Department. These paragraphs serve as reminders to ensure requirements are not overlooked. Consider the following design details:

a. Provide water and sanitation at unmanned facilities where sanitation is not available in the vicinity.

b. Place ATC electronic equipment in a dedicated space not shared with mechanical rooms or administrative offices.

c. Clean and seal all unfinished concrete floors, to include concrete sub floors under raised access flooring.

d. Provide any mechanical, electrical, or other facility systems in the electronic equipment space(s) in direct support of ATC communications equipment and strictly abide by working clearance definitions in the latest NEC.

e. Determine the exact locations of ATC communications equipment with input by the service-specific agencies that operate the facility (e.g., NIWC Atlantic and the Air Operations Department) as the initial design plan is developed. Note that depending upon the airfield's ATC requirements, the amount of equipment installed may vary. However, all facilities must adhere to the service-specific agency's clearance, installation, physical security, and location requirements for ATC communications equipment, which are based on the type of equipment to be installed, regulatory codes, and Service policies.

f. Do not include windows in ATC communications equipment spaces.

g. If electronic component repair involving soldering will be performed in the ATC communications facility, a designated work area is required. Navy: This work area must meet the requirements of NAVAIR 01-1A-23.

**6-2.4.1.5** Due to the increased use of electronic systems procured jointly by the FAA and Department of Defense (DOD), the facility grounding system must be designed and installed in accordance with FAA standards (FAA-STD-019f).

### 6-2.4.2 Site Work.

Provide an access road to allow maintenance vehicles access to the ATC Communications Facility. Provide parking space for two maintenance vehicles. See Chapter 2, paragraph "Access and Parking" for roadway and parking area design requirements.

#### 6-2.4.2.1 Sidewalks/Ramp

Provide an 8 ft (2.4 m). wide sidewalk/ramp from the main facility driveway to the main facility entrance. Provide a sidewalk that can support the weight of a small truck. If the

finished floor is above grade, a small loading dock and a ramp from the sidewalk to the main entrance are required. If the finished floor is at grade, a loading dock and ramp are not required.

### 6-2.4.3 Architectural Requirements.

Provide the following:

- Adequate space for equipment and equipment maintenance.
- Clear ceiling height of 10 feet (3 m).
- Work bench.
- Provide water and sanitation at unmanned facilities where sanitation is not available in the vicinity.
- Raised access floor or suspended cable trays.

Do not provide windows.

See NIWC – ATC Remote Communications Facility – FRD for more specific requirements.

#### 6-2.4.3.1 Critical Dimensions.

Provide a facility with an equipment room with minimum interior dimensions of 36 ft x 22 ft (11 m x 6.7 m)

#### 6-2.4.3.2 Equipment and Personnel Space Requirements.

The ATC communications facility must include space for the following:

a. Equipment
b. Lavatory (only if sanitation facilities not available in the vicinity).
c. Electrical (including uninterruptible power supply)
d. Mechanical
e. Emergency generator (E/G) space (can be outside on pad)
f. Data Communications Frame Area/Main Distribution Frame (MDF)
g. Antenna Towers

#### 6-2.4.3.3 Access Flooring.

An 18 in (450 mm) raised access floor system is required in ATC communications equipment spaces in lieu of floor trenches. See NIWC – ATC Remote Communications Facility – FRD for more specific requirements.

### 6-2.4.4 Structural Requirements.

Design and install foundations for each ATC communications facility antenna tower. Follow structural design requirements of UFC 3-301-01. Foundation design is dependent upon antenna tower height and soil conditions.

### 6-2.4.5 Pre-manufactured Buildings.

Consider using a pre-manufactured building as described in Chapter 2.

### 6-2.5 Mechanical Design Requirements.

a. Refer to UFC 4-133-01 for general and specific mechanical design requirements for ATC-related facilities. See also NIWC – ATC Remote Communications Facility – FRD for more specific requirements.

b. A chiller, boiler, and four-pipe distribution system with separate air handlers for each zone is not required if suitable Direct Expansion (DX) units can be used.

**c.** Do not use HVAC systems specifically designed for use with raised floors in facilities without raised floors.

### 6-2.5.1 Fire Protection Requirements.

Design and install fire protection and alarm systems in accordance UFC 3-600-01.

### 6-2.6 Electrical Requirements.

To avoid potential interferences with radar communications, locate power, communications, and control cables underground within 1,000 feet (305 m) of the antenna site. Ensure facility electrical systems do not interfere with radio communications.

Provide 120/208V, 100A, three-phase, 60 HZ commercial power service for the ATC Communications Facility with a minimum 30-circuit power panel.

All electrical power provided to the facility requires backup by an emergency generator. Power must be supplied on a split-bus system, which is herein denoted as “critical” and “non-critical.”

See NIWC – ATC Remote Communications Facility – FRD for more specific requirements.

### 6-2.6.1 National Electrical Code Compliance.

Provide ATC communications facility electrical grounding that comply with the requirements outlined in NEC Article 250, and FAA-STD-019f. Specifically, provide the ATC communications facility with grounding electrode systems and safety grounding systems in accordance with the NEC plus lightning protection, signal reference systems,

and multipoint grounding systems. Be aware that FAA requirements exceed those of the NEC.

### 6-2.6.2 Emergency Electrical Power.

Provide an emergency generator with automatic starting and switching capability as described in Chapter 2. Provide emergency power to the entire communications facility.

a. A minimum of 24 hours of emergency backup power is required for the ATC communications facility. Obtain ATC equipment loads from the service-specific agency that operates the facility. To ensure equipment operation during extended power outages, HVAC systems serving electronic equipment spaces must be supported by emergency generator (E/G) power. Consult with the facility users for E/G fuel storage capacity requirements above 24 hours.

b. Provide remote electronic monitoring and control of the E/G. Provide electronic control with the capability to monitor power status and fuel level as well as starting and stopping the generator. Coordinate the location of the remote monitoring equipment with the facility users.

### 6-2.6.3 Uninterruptible Power Supply.

a. A Facility UPS is required for the ATC communications facility.

b. The Facility UPS must be sized to provide the critical loads with power (plus a 25% spare capacity) for a minimum of 30 minutes to allow the emergency generator (E/G) to start, stabilize, and assume the load. See NIWC – ATC Remote Communications Facility – FRD for more specific requirements.

### 6-2.6.4 Facility Lightning Protection.

a. Design the lightning protection system to meet FAA-STD-019f requirements.

b. Take care to ensure lightning down-conductors do not run within the building structure, take the shortest route possible, and are properly terminated to an earth ground.

c. As specified in FAA-STD-019f, all lightning protection down-conductors must be connected to the EES via exothermic welds, including the connection of any down-conductors to the ground rod in the access well.

d. In accordance with the NEC, protect signal cables entering the ATC communications facility against lightning-induced transient voltage at the building entrance.

e. Air terminals on the facility roof are required to provide a zone of protection for any miscellaneous antennas mounted on the roof, such as the fire alarm antenna.

### 6-2.6.5 Grounding and Bonding.

In the design of the grounding and bonding system unless otherwise noted, FAA-STD-019f takes precedence. See NIWC – ATC Remote Communications Facility – FRD for more specific requirements.

### 6-2.6.6 Lighting.

LED lighting must meet the requirements of CFR 47, Part 15 (B), but is preferred and acceptable. Fluorescent lighting requires radio frequency interference (RFI) suppression ballasts. See NIWC – ATC Remote Communications Facility – FRD for more specific requirements.

## 6-2.7 Communications.

Provide 12-strand single mode fiber optic cable or 25 twisted pair communications line to provide required connectivity for data and telephone.

- Data connectivity from the Communications Facility to the Remote Unit located in the ATC Tower. (Dedicated pair)
- Data connectivity from the Communications Facility Shelter Fire Alarm to external monitoring system. (Dedicated pair)
- Telephone line for distance support to troubleshoot system.

Air Force: See fiber optic cable and modem requirements in AF T.O. 31Z-822-2, Chapter 4.

## 6-2.8 Safety Considerations.

### 6-2.8.1 Eyewash Station.

Provide an Occupational Safety and Health Administration (OSHA)-approved eyewash station in each equipment space.

### 6-2.8.2 Fire Extinguisher.

Provide at least one OSHA-approved fire extinguisher in the ATC communications facility.

### 6-2.8.3 First Aid Kits and Safety Gear.

The facility GEMD/ATCMD is responsible for providing any first aid kits and safety gear required for the ATC communications facility.

## 6-2.9 Connection/Interrelation to other Facilities.

Connect a dedicated DSN-capable telephone connection through to the proposed Communications Facility to facilitate distant support, troubleshooting, and corrective

maintenance due to the remote location. Connect the Communications Facility to the ATC Tower via fiber optic cable for remote monitoring.

**Figure 6-2 Typical ATC Communications Facility Siting Criteria**

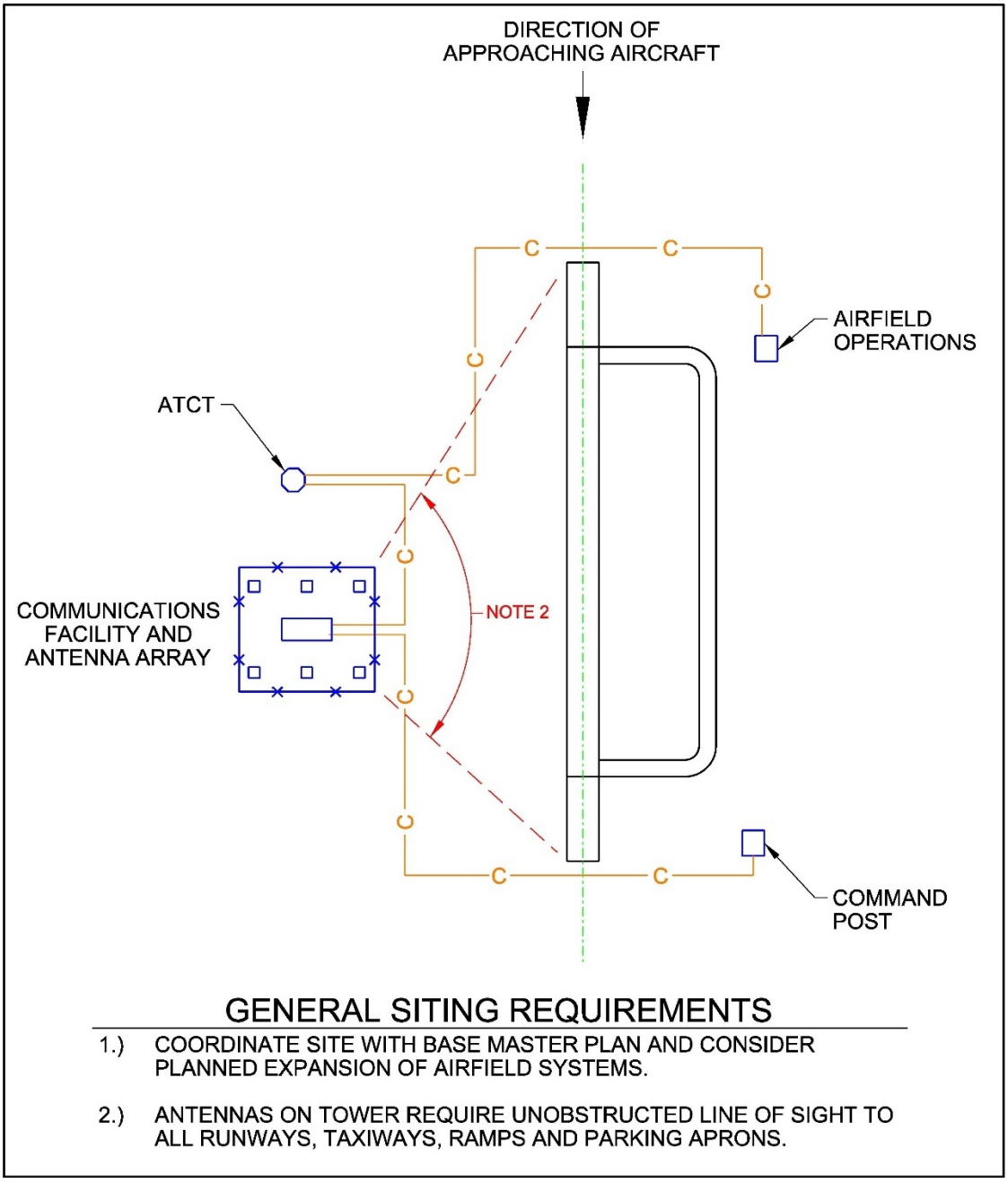


**Figure 6-3 Typical Communications Facility Site Plan**

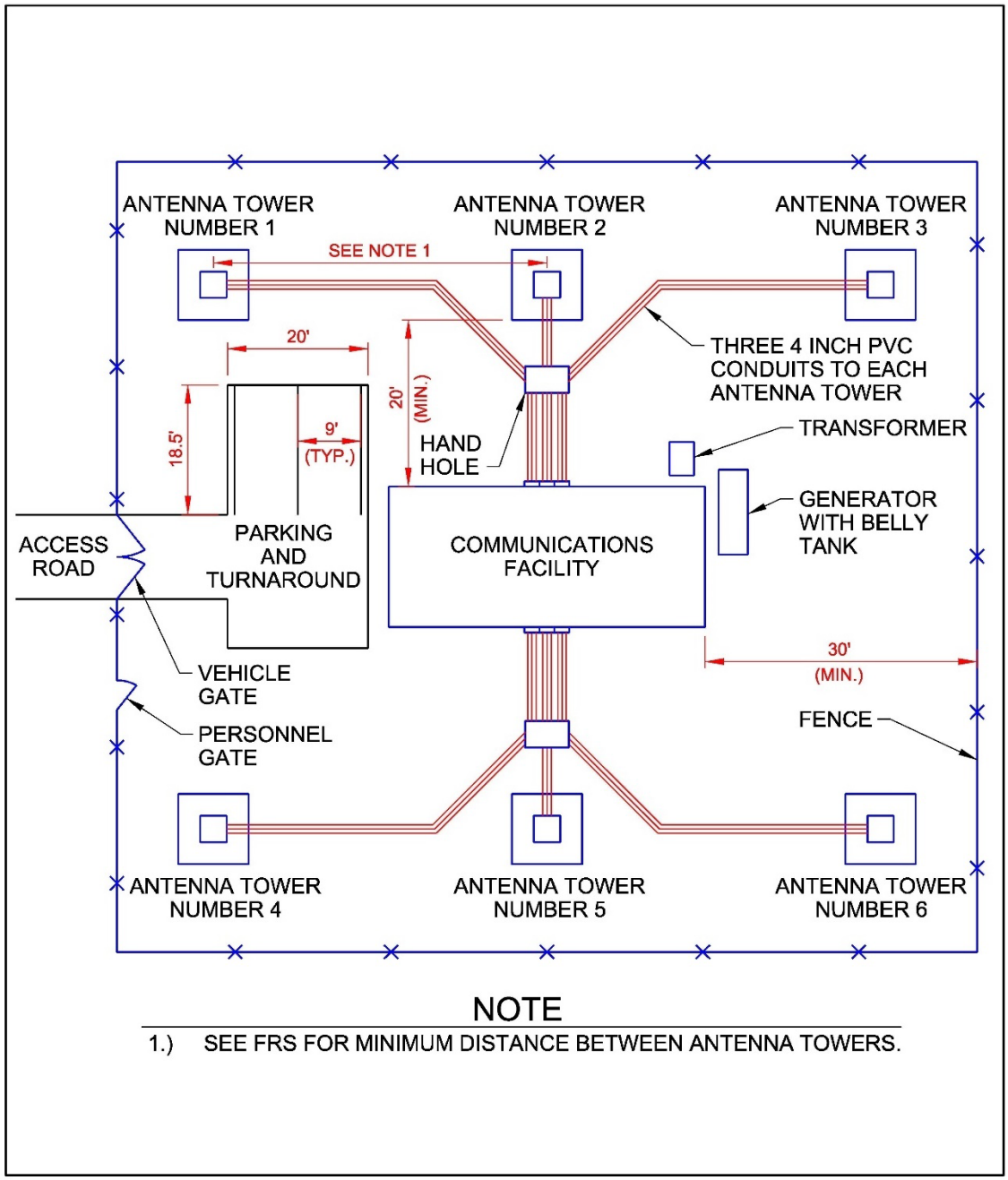


**Figure 6-4 Typical Communications Equipment Building Layout**

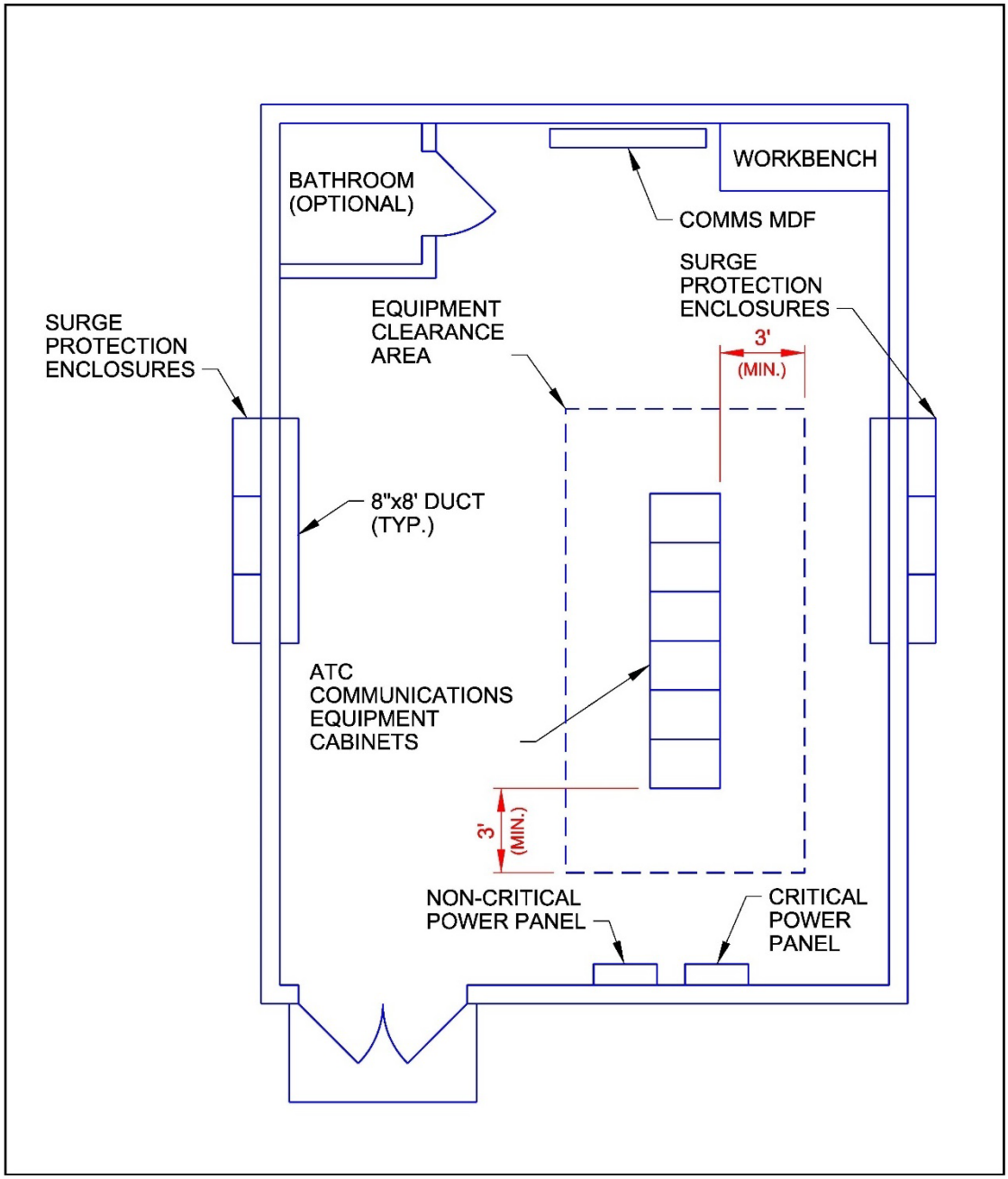
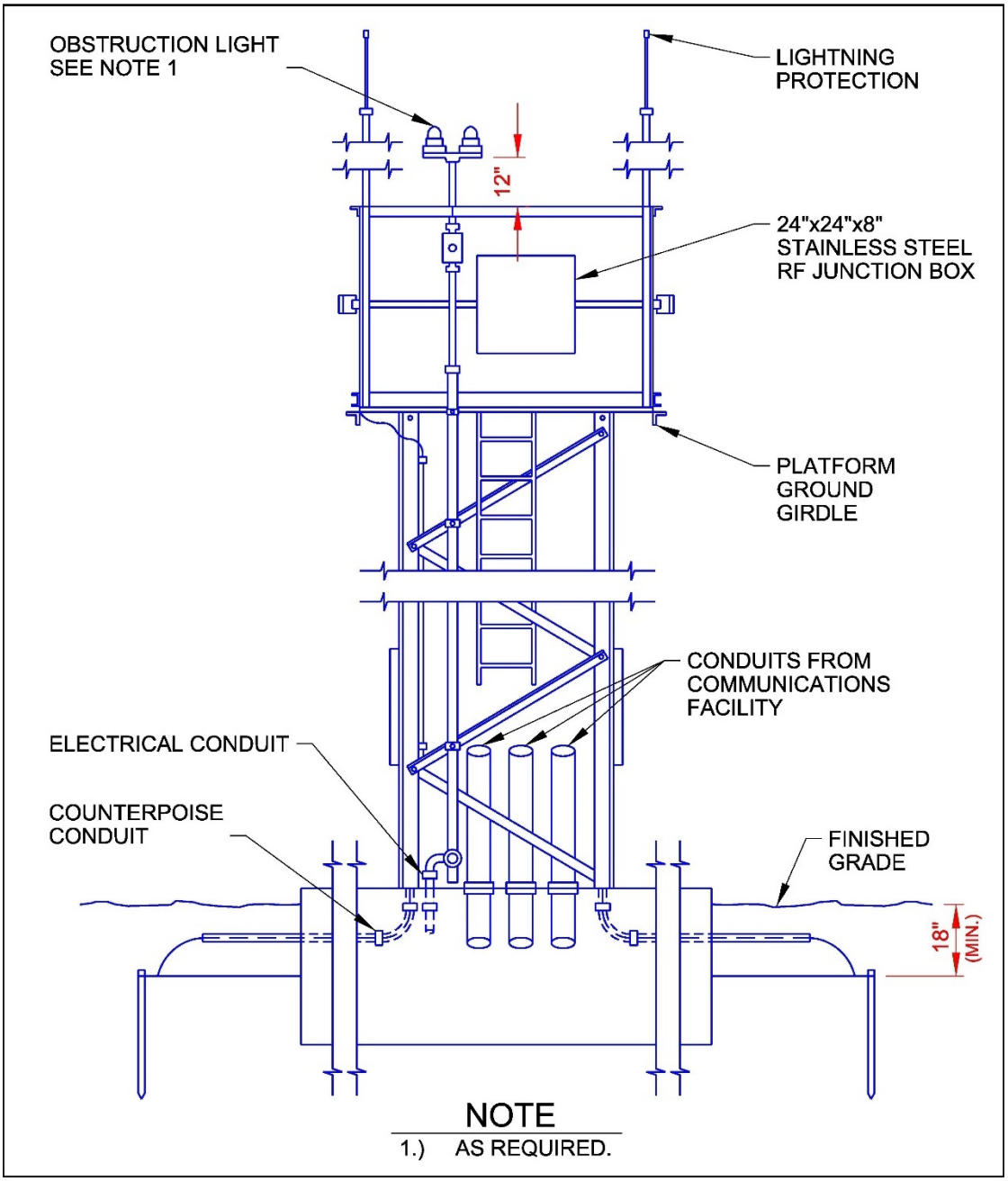


**Figure 6-5 Typical Communications Antenna Tower**



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# CHAPTER 7 WEATHER EQUIPMENT SUPPORTING AIRFIELDS

## 7-1 GENERAL INFORMATION.

### 7-1.1 Function.

The office where weather is recorded, analyzed and forecasted goes by different names within the Services and within different organizational structures. The equipment used to collect weather information on airfields are more common among the Services.

#### 7-1.1.1 Weather Office.

The Weather Office is most often located within a building, adjacent to Airfield Management or Air Operations. In some cases, the Weather Office may even be located at another installation. For those reasons, no facility requirements for a Weather Office are included in this UFC.

#### 7-1.1.2 Automated Surface Observing System (ASOS) and Fixed Base Weather Observing System (FBWOS).

A permanently installed automated ASOS or FBWOS (e.g., AN/FMQ-19, AN/FMQ-22, AN/FMQ-23) consists of a suite of weather sensors and processors capable of collecting, measuring or calculating and reporting a myriad of weather elements. These elements include, but are not limited to, wind direction and speed, prevailing visibility, present weather and visibility obstructions, cloud coverage and cloud base height, temperature, dew point, atmospheric pressure, lightning, and precipitation amounts. The observing system's primary sensor suite contains the majority of the sensors. Many locations also have additional discontinuity sensor suites. The discontinuity suite contains fewer sensors than the primary suite and is sited at the runway's roll out, midfield, or in the case of a multi-runway configuration, at an adjacent site along a parallel or intersecting runway to provide critical weather element readings that are representative of the respective location.

ASOS or FBWOS are automated stations operated and controlled by the DoD, National Weather Service, and FAA. They help the national weather system compile data on the entire United States and OCONUS sites, and not just for aviation purposes. ASOS reports are issued hourly with special reports issued more frequently when conditions change rapidly. The system went into operation in the early 1990s.

AWOS are automated stations generally operated and controlled by the FAA for aviation purposes. New reports are generated and transmitted every minute. The AWOS was the original aviation weather reporting system and AWOS stations are located solely at airports.

### 7-1.2 Certification and Commissioning.

To provide confidence in the quality of the meteorological data that the ASOS and FBWOS provides to users in the aviation community, the FAA has initiated a three-part

ASOS and FBWOS quality assurance process consisting of type certification, site-specific commissioning and annual revalidation.

For ASOS and FBWOS installed on military bases, follow the certification, commissioning and annual revalidation process described in FAA AC 150/5220-16, Chapter 2.

**Figure 7-1 ASOS Combined Sensor Group (CSG)**

## 7-2 AUTOMATED SURFACE OBSERVING SYSTEM (ASOS) OR FIXED BASE WEATHER OBSERVING SYSTEM (FBWOS).

The ASOS or FBWOS is a modular system consisting of two general components at two separate locations.

The sensor group (Combined Sensor Group (CSG) and discontinuity sensor groups for ASOS or primary and discontinuity sensor groups for FBWOS) is located near the runway and collects a variety of weather sensors. The ASOS Data Collection Package (DCP) or FBWOS Field Data Collection Unit (FDCU) in the sensor group then formats and transmits the data to the ASOS Acquisition Control Unit (ACU) or FBWOS Terminal Data Acquisition Unit (TDAU).

The ACU or TDAU is typically located in close proximity to the Air Traffic Control equipment (e.g., ATCT equipment room). The ACU or TDAU receives data from the sensor group (via radio frequency modem link or via a direct line link) and performs the

algorithmic functions to produce weather products. The weather data is provided via local displays, remote dial-in, voice phone, and one way transport via modem to an Advanced Weather Interactive Processing System (AWIPS) hub. Then the weather data is transported to the NWS gateway.

Potential sensors included in an ASOS or FBWOS are listed below.

- Surface Wind Speed and Direction
- Ambient Air Temperature
- Dew Point Temperature
- Atmospheric Pressure
- Visibility
- Sky Condition
- Precipitation Type Discrimination (rain, snow, drizzle, etc.)
- Precipitation Occurrence (Yes/No)
- Freezing precipitation detection
- Precipitation Accumulation
- Lightning detection

### 7-2.1 Key Documents.

| | |
|---|---|
| UFC 3-260-01 | *Airfield and Heliport Planning and Design* |
| FCM-S4-2019 | *Federal Standard for Siting Meteorological Sensors at Airports, Office of the Federal Coordinator for Meteorological Services and Supporting Research* |
| FAA AC 70/7460-1M | *Obstruction Marking and Lighting* |
| FAA AC 150/5220-16 | *Automated Weather Observing Systems (AWOS) for Non-Federal Applications* |
| FAA Order JO 6560.20C | *Siting Criteria for Automated Weather Observing Systems (AWOS)* |
| FAA-STD-019f | *Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment* |

### 7-2.2 Siting.

Site ASOS or FBWOS equipment on DoD airfields and heliports using the guidance included in FCM-S4-2019. Special care is necessary in selecting appropriate locations for installation of sensors to assure that the resultant observations are representative of the meteorological conditions affecting aviation operations. When applying these criteria, consider future plans for the airport that could impact placement of sensors, e.g., installation of an Instrument Landing System (ILS), Microwave Landing System (MLS), runway construction, etc.

Figure 7-2 illustrates the typical position of weather sensors relative to the runway. Figure 7-3 illustrates the typical position of weather sensors relative to the Glide Slope antenna and shelter. Figure 7-4 shows one arrangement for multiple items in a Combined Sensors Group.

Navy: Site ASOS equipment on DoD airfields and heliports using the guidance included in FCM-S4-2019.

- For airports with only Visual or Non-Precision Runways, site the ASOS minimum 500 feet (152 m) and maximum 1,000 feet (305 m) from the centerline of the runway.
- For airports with Precision Instrument Runways without RVR instrumentation, there are two options for siting from centerline: a) minimum 750 feet (229 m) and maximum 1,000 feet (305 m); or b) locate the ASOS behind the Glide Slope shelter or MLS elevation station.
- For airports with Precision Instrument Runways with RVR instrumentation, site the ASOS minimum 400 feet (122 m) from the centerline of the runway and in accordance with FCM-S4-2019.
- For all runways, site the ASOS longitudinally as close as possible to the touchdown point (between 1,000 and 3,000 feet (305 and 914 m) from the runway threshold).

Army and Air Force: Align the FBWOS primary and discontinuity sensor groups parallel to the runway and not less than 300 feet (91 m) (Class A/Rotary-Wing Runways) or 400 feet (122 m) (Class B Runways) from centerline of the runway, as close as possible to the touchdown point (between 1,000 and 3,000 feet (305 and 914 m) from the runway threshold). For siting criteria of a FBWOS near taxiways and parking aprons on airfields and heliports, use Tables 5-1, 5- 2, and 6-1 of UFC 3-260-01 to provide appropriate clearances between aircraft and the weather equipment. Selecting appropriate locations to install sensor groups is a critical consideration for flight operations safety as well as to ensure the weather elements collected are representative of the meteorological conditions affecting flight operations.

See FCM-S4-2019 for clearance and mounting height requirements for individual sensors in the sensor group.

### 7-2.3 Security.

ASOS and FBWOS facilities are normally located within the airfield restricted area. This siting typically meets the minimum security measures for external security. When the facility is located within a restricted area of a lower level of security or is located remote and outside of an established restricted area, provide additional measures to meet the minimum security requirements for the level of security assigned to the facility.

### 7-2.4 Facility Design Guidance.

#### 7-2.4.1 Site Work.

Provide an access road to allow maintenance vehicles access to the sensor group(s) on the airfield. Provide parking space for one maintenance vehicle. See Chapter 2, paragraph “Access and Parking” for roadway and parking area design requirements.

#### 7-2.4.2 Architectural Requirements.

There are no architectural requirements for the ASOS or FBWOS equipment.

#### 7-2.4.3 Structural Requirements.

The wind sensor tower is mounted on a concrete foundation and may vary in dimension depending on type of system suite. Other sensors are mounted on metal posts set into the 12” diameter concrete foundations minimum 24” into the ground (or extending below frost line) with gravel around the posts. Install the top surface of these concrete foundations flush with the surrounding surface grade. See Figure 7-5 and 7-6 for typical concrete foundations for a ASOS CSG. Site adapt the minimum size and depth for local environmental conditions and soils.

### 7-2.5 Mechanical Requirements.

There are no mechanical facility requirements for the ASOS or FBWOS.

### 7-2.6 Electrical Power.

Provide 120V, 30A, single-phase, 60 Hz commercial power service to the sensor group. Provide 120V, 20A single-phase, 60Hz commercial power service to the ACU or TDAU.

#### 7-2.6.1 Emergency Electrical Power.

The ASOS system is designed to return to normal operation without human intervention after a power outage. The system is equipped with UPS battery back up to allow for orderly shutdown of the system in the event of source power loss. When power is restored, the system automatically returns to service and begins outputting sensor data only after internal sensor diagnostics allow data to pass, preventing dissemination of erroneous data.

### 7-2.6.2 Lighting.

If a separate tower is used for the wind sensor, provide daytime marking and nighttime lighting in accordance with the guidelines set forth in the latest edition of FAA AC 70/7460-1.

### 7-2.6.3 Lightning Protection, Grounding and Bonding.

Install lightning protection systems in accordance with FAA-STD-019f.

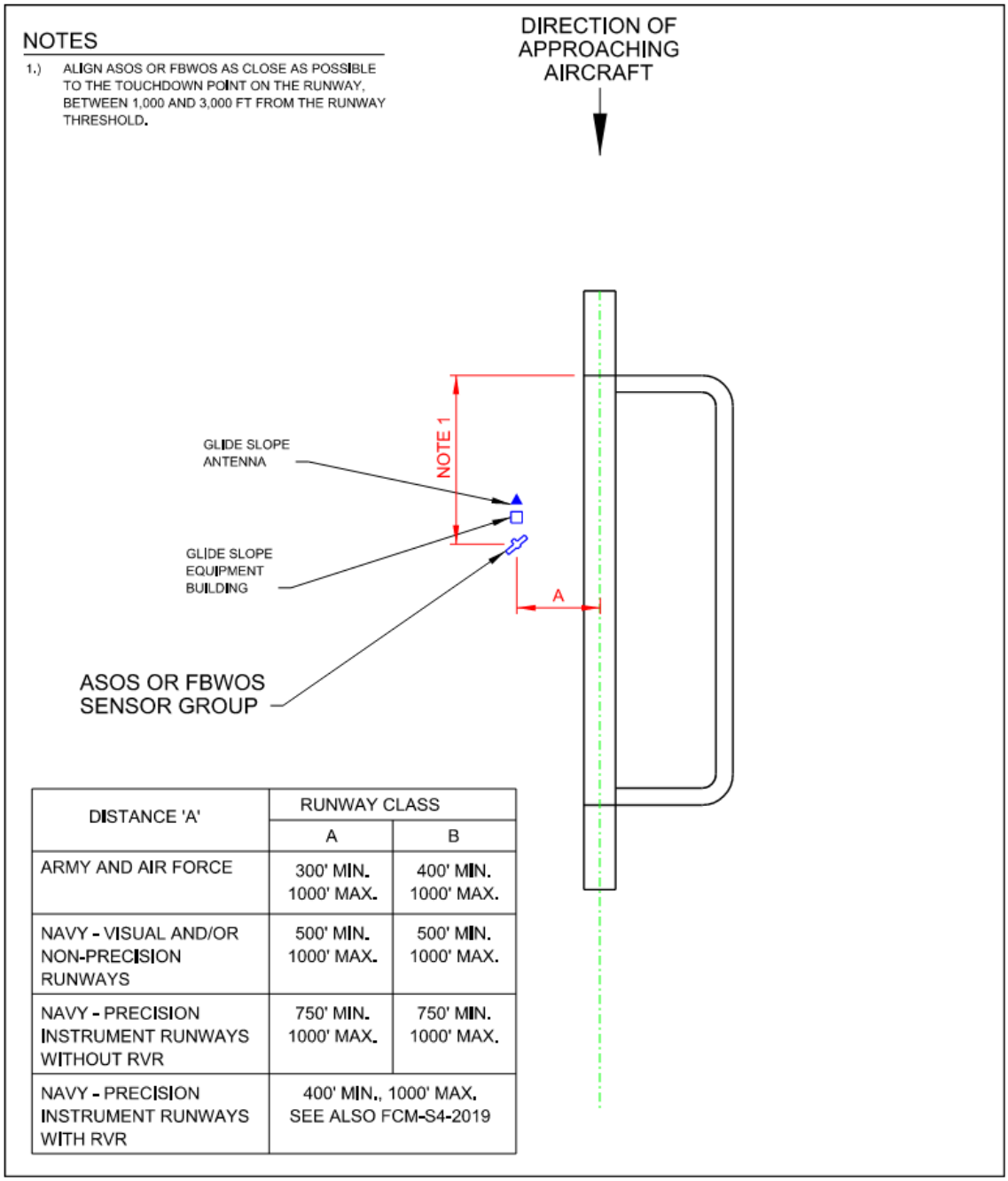
## 7-2.7 Communications.

Provide 12-strand single mode fiber optic cable, 25 twisted pair communications line or RF antenna signal between the DCP and ACU or FDCU and TDAU. Provide required data connectivity (fiber optic preferred) to receiving units located in the ATC Tower, Base Operations and Weather Office.

## 7-2.8 Connection/Interrelation to other Facilities.

Connect the ASOS ACU or FBWOS TDAU to the ATC Tower, Base Operations and Weather Office via fiber optic cable or twisted pair communications cable for remote monitoring.

## Figure 7-2 ASOS or FBWOS Siting




| DISTANCE 'A' | RUNWAY CLASS | |
|---|---|---|
| | A | B |
| ARMY AND AIR FORCE | 300' MIN. 1000' MAX. | 400' MIN. 1000' MAX. |
| NAVY - VISUAL AND/OR NON-PRECISION RUNWAYS | 500' MIN. 1000' MAX. | 500' MIN. 1000' MAX. |
| NAVY - PRECISION INSTRUMENT RUNWAYS WITHOUT RVR | 750' MIN. 1000' MAX. | 750' MIN. 1000' MAX. |
| NAVY - PRECISION INSTRUMENT RUNWAYS WITH RVR | 400' MIN., 1000' MAX. SEE ALSO FCM-S4-2019 | |

**Figure 7-3 ASOS or FBWOS Site Layout**

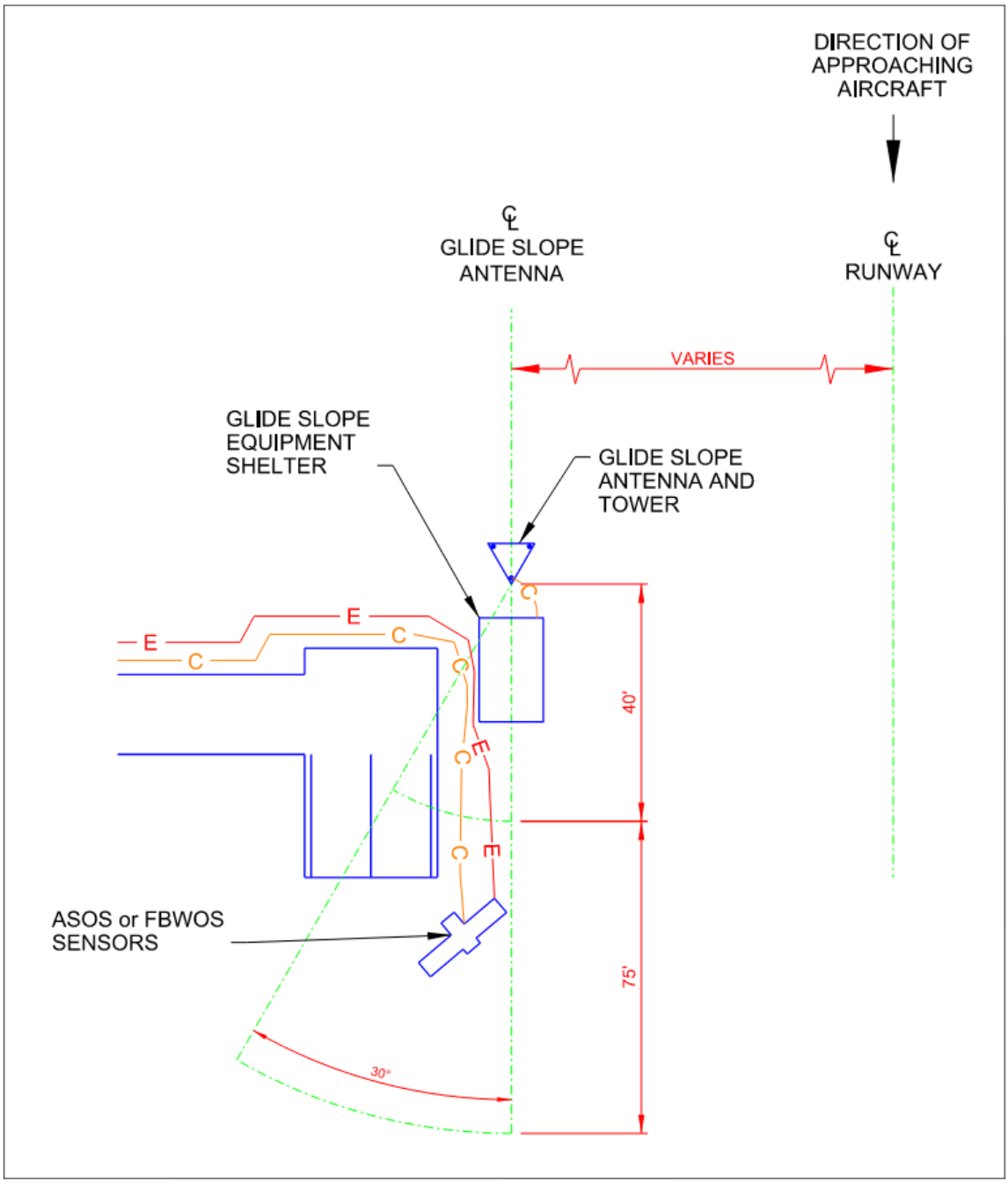
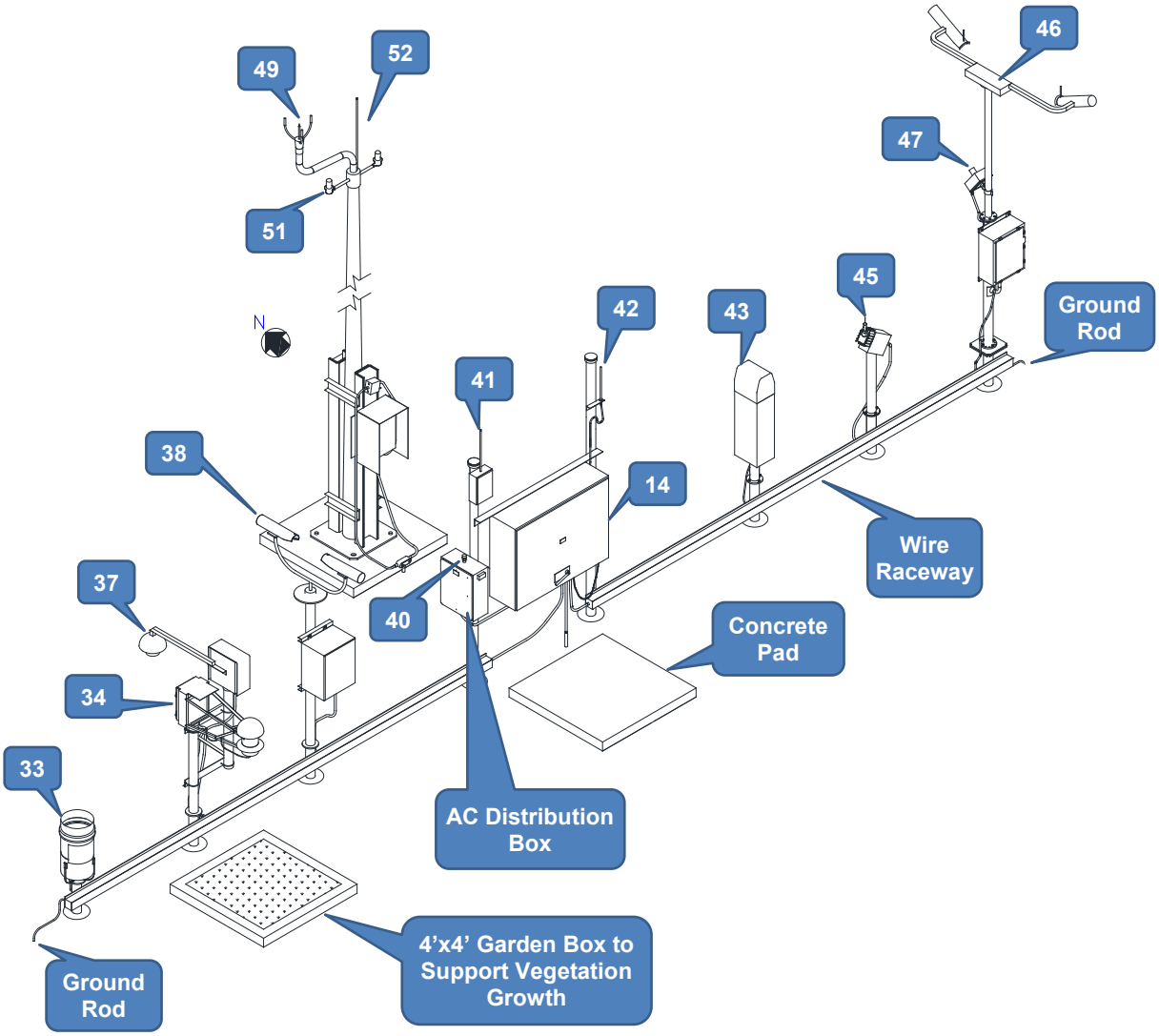


**Figure 7-4 Typical ASOS Combined Sensor Group**




| Item No. | Description |
|---|---|
| 14 | Data Collection Package (DCP) |
| 33 | Tipping Bucket |
| 34 | Sensor, Temperature |
| 37 | Sensor, DTS1 Dew Cell |
| 38 | Sensor, Present Weather |
| 40 | Sensor, Day/Night |
| 41 | Sensor, Thunderstorm |
| 42 | Antenna, RF |
| 43 | Ceilometer, CL31 |
| 45 | Sensor, Freezing Rain |
| 46 | Sensor, Visibility |
| 47 | Sensor, Day/Night |
| 49 | Sensor, Wind Speed/Direction |
| 51 | Light, Obstruction |
| 52 | Rod, Lightning |

**Figure 7-5 Typical ASOS Foundation Plan**

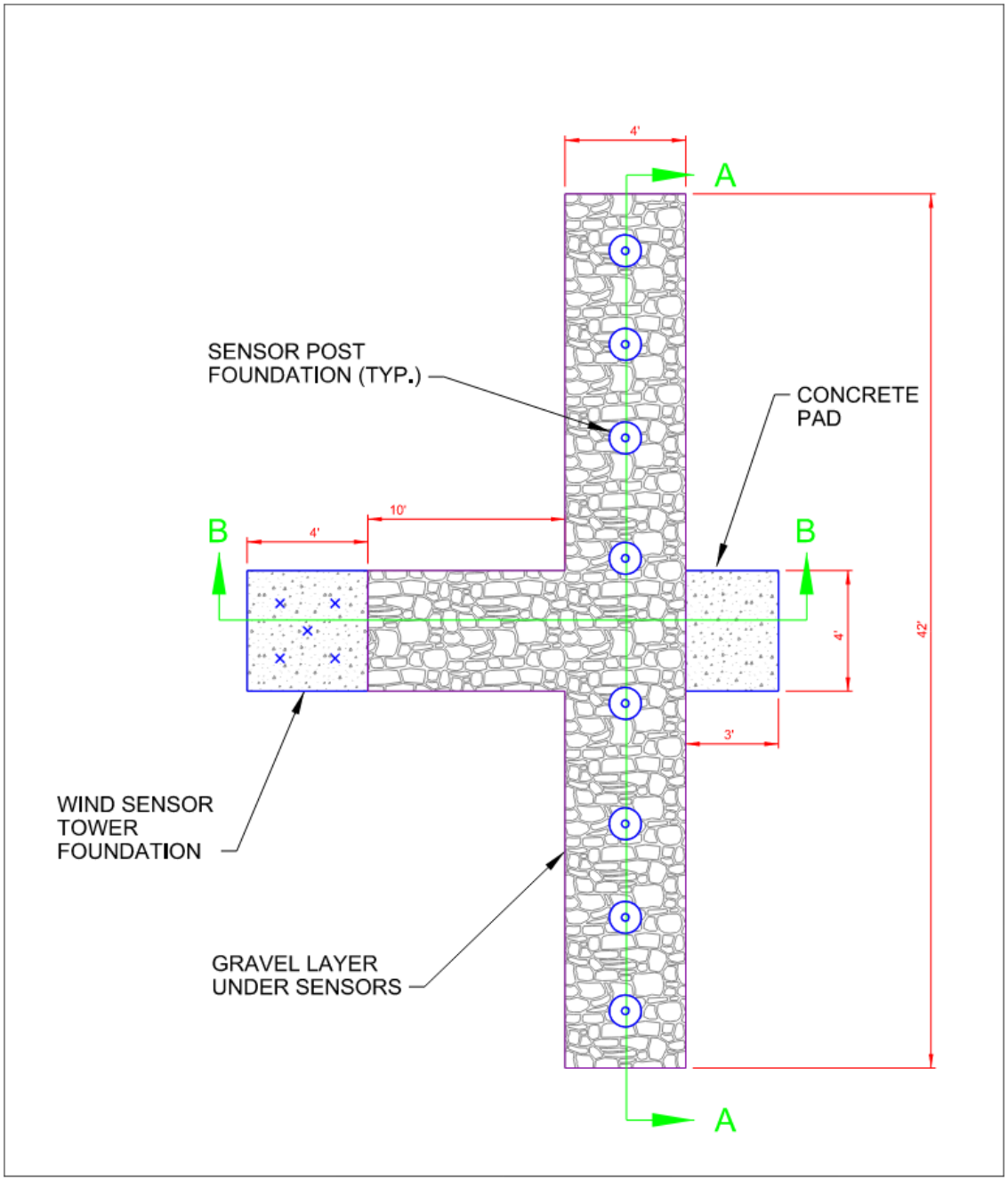
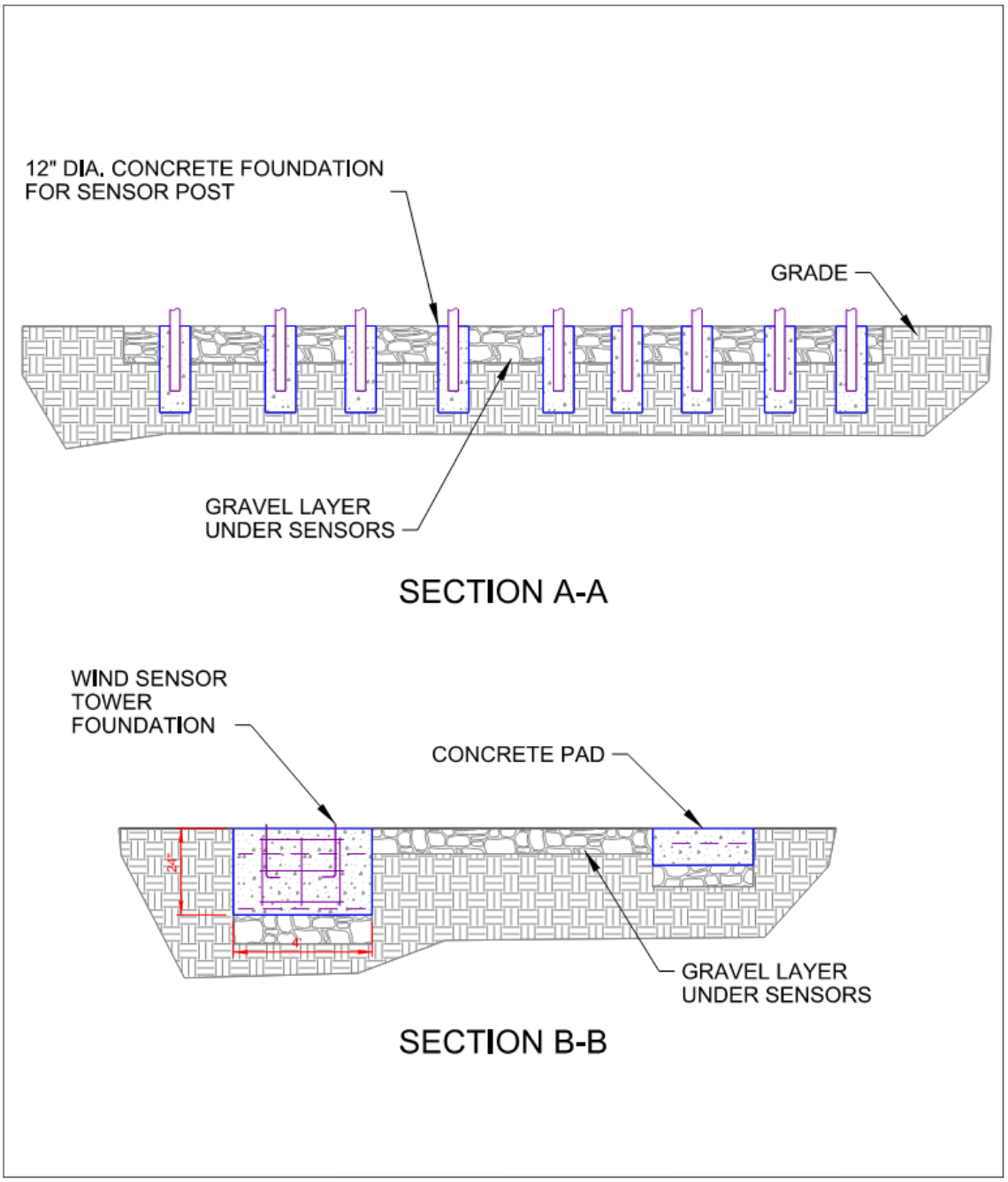


**Figure 7-6 Typical ASOS Foundation Sections**



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# APPENDIX A BEST PRACTICES

## A-1 SUBJECT MATTER EXPERTS (SMEs).

The facilities described in this UFC are unique and not routinely constructed. Contact Service Specific SMEs for guidance early in the programming, siting and design processes to obtain the most up-to-date guidance.

## A-2 FACILITIES REQUIREMENTS DOCUMENTS (FRDs).

Many of the facilities described in this UFC support specialized equipment that may have been purchased in large quantities and then distributed to individual airfields. Whenever possible, obtain the FRD associated with the specific equipment to be installed for more detailed installation guidance.

## A-3 UFC COORDINATION.

Coordinate all design elements with the Core Discipline requirements listed in UFC 1-200-01.

## A-4 WAIVERS/EXEMPTIONS.

Site the facility to be compatible with the requirements of UFC 3-260-01. Where unusual circumstances require a non-standard installation, consult UFC 3-260-01, Appendix B, Section 1 for waiver processing procedures. For standard exceptions from waivers, consult UFC 3-260-01, Appendix B, Section 13 (Army and Air Force) or UFC 3-260-01, Chapter 2 (Navy and Marine Corps).

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# APPENDIX B GLOSSARY

## B-1 ACRONYMS

| | |
|---|---|
| A & E | Architectural and Engineering |
| ACU | Acquisition Control Unit |
| AFCEC | Air Force Civil Engineer Center |
| AGL | Above Ground Level |
| AICUZ | Land Use Compatibility |
| ARSR | Air Route Surveillance Radar |
| ASR | Air Surveillance Radar |
| ASTM | American Society for Testing and Materials |
| ATC | Air Traffic Control |
| ATC&LS | Air Traffic Control and Landing Systems |
| ATCRBS | Air Traffic Control Radar Beacon System |
| ATSCOM | Air Traffic Service Command |
| ASOS | Automated Surface Observing System |
| AWIPS | Advanced Weather Interactive Processing System |
| AWOS | Automated Weather Observing Systems |
| BIA | Bilateral Infrastructure Agreement |
| CCR | Criteria Change Request |
| CSG | Combined Sensor Group |
| DCP | Data Collection Package |
| DME | Distance Measuring Equipment |
| DoD | Department of Defense |
| DX | Direct Expansion |
| E/G | Emergency Generator |

| | |
|---|---|
| FAA | Federal Aviation Administration |
| FBPAR | Fixed Base Precision Approach Radar |
| FBWOS | Fixed Base Weather Observing System |
| FDCU | Field Data Collection Unit |
| FFM | Far Field Monitor |
| FLOLS | Fresnel Lens Optimal Landing System |
| FRD | Facility Requirements Document |
| G/A | Ground-to-Air |
| GS | Glide Slope |
| HERF | Hazards of Electromagnetic Radiation to Fuel |
| HERO | Hazards of Electromagnetic Radiation to Ordnance |
| HERP | Hazards of Electromagnetic Radiation to Personnel |
| HNFA | Host Nation Funded Construction Agreements |
| HQUSACE | Headquarters, U.S. Army Corps of Engineers |
| ICLS | Instrument Carrier Landing System |
| IFLOLS | Improved Fresnel Lens Optical Landing System |
| IFR | Instrument Flight Rules |
| ILS | Instrument Landing System |
| JCF | Joint Control Facility |
| LOC | Localizer |
| LOS | Line of Sight |
| MDF | Main Distribution Frame |
| MLS | Microwave Landing System |
| MTI | Moving Target Indicator |
| MTRACON | Military Terminal Radar Approach Control Facility |

| | |
|---|---|
| NAVAID | Navigational Aid |
| NAVFAC SYSCOM | Naval Facilities Engineering Systems Command |
| NAWCAD | Naval Air Warfare Center Aircraft Division |
| NEPA | National Environmental Policy Act |
| NFPA | National Fire Protection Association |
| OSHA | Occupational Safety and Health Administration |
| PAR | Precision Approach Radar |
| RADHAZ | Radiation Hazard |
| RASS | Range Airspace Surveillance |
| RF | Radio Frequency |
| RFI | Radio Frequency Interference |
| RTR | Remote Transmitter/Receiver |
| RVR | Runway Visual Range |
| Rx | Receiver |
| SOF | Safety of Flight |
| SOFA | Status of Forces Agreements |
| TACAN | Tactical Air Navigation |
| TDAU | Terminal Data Acquisition Unit |
| Tx | Transmitter |
| Tx/Rx | Collocated Transmitter/ Receiver Facility |
| UFAS | Uniform Federal Accessibility Standards |
| UFC | Unified Facilities Criteria |
| UHF | Ultra High Frequency |
| UPS | Uninterrupted Power Supply |
| U.S. | United States |

| | |
|---|---|
| VHF | Very High Frequency |
| VOR | Very High Frequency Omni-Directional Range |
| W/G | Waveguide |

# APPENDIX C REFERENCES

## FEDERAL AVIATION ADMINISTRATION – ADVISORY CIRCULARS

https://www.faa.gov/airports/resources/advisory_circulars/

FAA AC 70/7460-1, *Obstruction Marking and Lighting*

FAA AC 150/5220-16, *Automated Weather Observing Systems (AWOS) for Non-Federal Applications*

FAA AC 150/5220-23, *Frangible Connections*

FAA AC 150/5300-13, *Airport Design*

## FEDERAL AVIATION ADMINISTRATION – ORDERS AND STANDARDS

https://www.faa.gov/regulations_policies/orders_notices/

FAA Order 6310.6, *Primary/Secondary Terminal Radar Siting handbook*

FAA Order 6340.15, *Primary/Secondary En Route Radar Siting Handbook*

FAA Order 6580.2, *Remote Communications Facility Siting Criteria Handbook*

FAA Order 65580.3B, *Remote Communications Facilities installation Standards Handbook* (not accessible outside FAA)

FAA Order 6580.6A, *Remote Communications Facilities Siting Process* (not accessible outside FAA)

FAA Order 6750.16, *Sitting Criteria for Instrument Landing Systems*

FAA Order 6780.5, *DME Installation Standards Handbook Type FA-96-39* (Request for Lead Service Agency)

FAA Order 6780.8, *Distance Measuring Equipment (DME) Installation Standards Handbook Type FA-9783* (Request for Lead Service Agency)

FAA Order 6820.10, *VOR, VOR/DME, and VORTAC Siting Criteria*

FAA Order 6830.5, *Criteria for Siting Microwave Landing Systems*

FAA Order JO 6560.20C, *Siting Criteria for Automated Weather Observing Systems (AWOS)*

FAA-STD-019f, *Lighting and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities*

**NATIONAL FIRE PROTECTION ASSOCIATION**

https://nfpa.org/Codes-and-Standards

NFPA 70, *National Electric Code*

NFPA 101, *Life Safety Code*

NFPA 780, *Standard for the Installation of Lightning Protection Systems*

**US AIR FORCE**

https://www.e-publishing.af.mil/

AF T.O. 31Z3-822-2, *Air Traffic Control Landing System (ATCALS) Site Requirements 404L*

AF T.O. 31P5-2GPN22-12, *Facility Manual – Radar Set Group, Type AN/GPN-22(V)*

**US ARMY MILITARY SURFACE DEPLOYMENT & DISTRIBUTION COMMAND, TRANSPORTATION ENGINEERING AGENCY**

https://www.sddc.army.mil/sites/TEA/Pages/default.aspx

SDDCTEA Pamphlet 55-17, *Traffic and Safety Engineering for Better Entry Control Facilities*

**US NAVY**

https://www.atc.navy.mil (CAC card required to access)

N65236-ATCF-FRD-0003 v2.0, NIWC – *Air Traffic Control Remote Communications Facility – Facility Requirements Document*

NAVFACINST 11010.45A, *Site Approval Request Process*

OPNAVINST 5100.23G,

SSC PAC PAR SPSPP, *SPAWARSYSCEN Pacific (SSC PAC) Precision Approach Radar (PAR) Site Preparation Standard Plan Package*

**TRI-SERVICES ELECTRICAL WORKING GROUP**

https://www.wbdg.org/ffc/dod/supplemental-technical-criteria

TSEWG TP-19, *Static Uninterruptible Power Supply (UPS)*

**UNIFIED FACILITIES CRITERIA**

https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

UFC 1-200-01, *DoD Building Code*

UFC 2-000-05N, *Facility Planning for Navy and Marine Corps Shore Installation*

UFC 2-100-01, *Installation Master Planning*

UFC 3-101-01, *Architecture*

UFC 3-110-03, *Roofing*

UFC 3-201-01, *Civil Engineering*

UFC 3-220-01, *Geotechnical Engineering*

UFC 3-250-01, *Pavement Design for Roads and Parking Areas*

UFC 3-260-01, *Airfield and Heliport Planning and Design*

UFC 3-301 01, *Structural Engineering*

UFC 3-401-01, *Mechanical Engineering*

UFC 3-410-01, *Heating, Ventilating and Air Conditioning Systems*

UFC 3-420-01, *Plumbing Systems*

UFC 4-133-01, *Air Traffic Control and Air Operations Facilities*

UFC 3-450-01, *Noise and Vibration Control*

UFC 3-460-01, *Design: Petroleum Fuel Facilities*

UFC 3-501-01, *Electrical Engineering*

UFC 3-520-01, *Interior Electrical Systems*

UFC 3-530-01, *Design: Interior and Exterior Lighting and Controls*

UFC 3-535-01, *Visual Air Navigation Facilities*

UFC 3-540-01, *Engine-Driven Generator Systems for Prime and Standby Power Applications*

UFC 3-575-01, *Lighting and Static Electricity Protection Systems*

UFC 3-580-01, *Telecommunications Building Cabling Systems Planning and Design*

UFC 3-600-01, *Fire Protection Engineering for Facilities*

UFC 4-010-01, *DoD Minimum Antiterrorism Standards for Buildings*

UFC 4-022-03, *Security Fences and Gates*

UFC 4-010-06, *Cybersecurity of Facility-Related Control System*

**US DEPARTMENT OF COMMERCE/NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION**

https://www.icams-portal.gov/publications/fmh/siting/fcm-s4-2019.pdf

FCM-S4-2019, *Federal Standard for Sitting Meteorological Sensors at Airports, Office of the Federal Coordinator for Meteorological Services and Supporting Research*