UFC 3-575-01
1 July 2012
Change 1 October 1, 2021

UNIFIED FACILITIES CRITERIA (UFC)

LIGHTNING AND STATIC ELECTRICITY PROTECTION SYSTEMS

LIGHTNING AND STATIC ELECTRICITY PROTECTION SYSTEMS

U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING COMMAND

AIR FORCE CIVIL ENGINEER CENTER (Preparing Activity)

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

Change No.	Date:	Location
1	1 October 2021	Critical and substantive CCRs and service-specific requirements throughout Chapters 1-3; new Chapter 4.

This UFC supersedes MIL-HDBK 1004/6, *Lightning Protection*, and Army TM 5-811-3/ Air Force AFM 88-9 Chapter 3, *Electrical Design, Lightning and Static Electricity Protection*.

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. UFCs 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.

UFCs 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), and Air Force Center for Engineering and the Environment (AFCEE) 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 should be sent to the respective service proponent office by the following electronic form: Criteria Change Request. The form is also accessible from the Internet sites listed below.

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

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

Hard copies of UFCs printed from electronic media should be checked against the current electronic version prior to use to ensure that they are current.

AUTHORIZED BY:

JAMES C. DALTON, P.E.
Chief, Engineering and Construction
U.S. Army Corps of Engineers

JOSEPH E. GOTT, P.E.
Chief Engineer
Naval Facilities Engineering Command

TERRY G. EDWARDS, P.E.
Director, Air Force Center for
Engineering and the Environment
Department of the Air Force

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

UNIFIED FACILITIES CRITERIA (UFC)
CHANGE SUMMARY SHEET

Document: UFC 3-575-01, *Lightning and Static Electricity Protection Systems*

Superseding: MIL-HDBK 1004/6, *Lightning Protection*, and Army TM 5-811-3/ Air Force AFM 88-9 Chapter 3, *Electrical Design, Lightning and Static Electricity Protection*.

Description: **\1** UFC 3-575-01 provides guidance for design criteria, establishes standards for static electricity protection and lightning protection from both direct and indirect strikes and surges, and describes bonding and grounding methods related to those static and lightning protection systems. This UFC applies to facilities and other structures. **/1/**

Reasons for Document:

- **\1** Incorporate new and revised industry standards applicable to DoD.
- Provide technical requirements for systems that protect assets and personnel.
- Describe and allow the use of equivalent protection when supported by calculations or justification.
- Clarify who is qualified to decide “equivalency” of substitutions in material and equipment submittals.
- Provide standard methods of inspection to ensure LPS systems remain compliant with codes and regulations (NFPA and OSHA). **/1/**
- Standardize the Tri-service criteria using NFPA 780. Applicable portions of UL 96A are incorporated, but UL 96A is no longer relied upon as a basis for compliance.

\1\ Impact: The following benefits should be realized:

- Improved guidance for surge protective device requirements. **/1/**
- Standardized guidance to assist engineers in the development of the plans, specifications, calculations, and Design/Build Request for Proposals (RFP).
- **\1** Standardized guidance to assist maintenance and inspection personnel in repairs which involve minimal design.
- Coordination with all electrical-related UFCs and UFGSs and consistency in guidance with the other electrical-related UFCs and UFGSs. **/1/**

Unification Issues:

- The Air Force uses a Shepherd's Crook design for static ground protection, which is shown in Figure 2-2. Although not considered a unification issue, it is listed as an Air Force-only criterion since the Army no longer uses this style and the Navy never did use this style.
- A 100% test point inspection is required by all services. This inspection must be performed by a third party (not the designer and not the installer). This must also be accomplished on smaller projects, such as roofing and HVAC, where lightning protection systems are installed on the facility **\1** to ensure the LPS is not damaged or reconfigured during construction.
- **For Navy:** Explosives Safety must be involved in a 100 percent test point inspection prior to acceptance, with 100 percent testing repeated at six months and one year.
- **For Army:** 100 percent review of test points plus requirements in Army Pamphlet 385-64 will be the basis of approval. **/1/**

TABLE OF CONTENTS

FIGURES

TABLES

This Page Intentionally Left Blank

CHAPTER 1 INTRODUCTION

1-1 PURPOSE.

This UFC provides policy and design requirements for static electricity protection, and for lightning protection systems and related grounding for facilities and other structures. The information provided herein must be utilized by electrical engineers, including A/Es, in the development of the plans, specifications, calculations, and Design/Build requests for Proposal (RFP) and must serve as minimum electrical design requirements. It is applicable to the traditional electrical services customary for Design-Bid-Build construction contracts. Project conditions may dictate the need for a design that exceeds these minimum requirements. A design analysis is required.

UFC 3-501-01, *Electrical Engineering*, provides the governing criteria for electrical systems, explains the delineation between the different electrical-related UFCs, and refers to UFC 3-575-01 for static electricity protection and lightning protection system requirements. Refer to UFC 3-501-01 for design analysis, calculation, and drawing requirements.

\1\ For Air Force: One set of half-size drawings is required for AFCEC/COSM at each design milestone. **/1/**

1-2 APPLICABILITY.

Compliance with this UFC is mandatory for DoD facilities located on or outside DoD installations, whether acquisition is by appropriated or non-appropriated funds or by third party finance and construction. Facilities cover all temporary or permanent structures, including waterfront facilities, outside storage, and shore protection for ships and aircraft.

Criteria in this UFC apply to DoD-leased facilities outside DoD installations, whether by appropriated or non-appropriated funds, or by third party finance and construction, when DoD or DoD contractor maintains the facility.

1-3 GENERAL BUILDING REQUIREMENTS.

UFC 1-200-01, *General Building Requirements*, provides applicability of model building codes and government-unique criteria for typical design disciplines and building systems, as well as for accessibility, antiterrorism, security, sustainability, and safety.

Use this UFC in addition to UFC 1-200-01 and the UFCs and government criteria referenced therein. **\1** If conflicts between UFCs are noted, this UFC takes precedence for LPS and static systems. **/1/**

\1\

1-4 EQUIVALENCY.

Equivalency is an alternative to codes and specifications that has the same protective results as the method or equipment specified. Equivalency must be determined only by a certified person trained to perform installation, maintenance, testing, and repair of the systems addressed in this UFC, or by an electrical engineer. /1/

1-5 REFERENCES.

Appendix B contains a list of references used in this UFC. References applicable to a specific topic are also listed and described in the appropriate sections of this UFC.

1-6 KEY CODES AND STANDARDS.

Comply with the following codes and standards:

- IEEE 142, *IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems*
- \1\ IEEE 1100, Powering and Grounding Electronic *Equipment*, "Emerald" Book /1/
- NFPA 70, *National Electrical Code*
- NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*
- NFPA 77, *Recommended Practice on Static Electricity*
- NFPA 780, *Standard for the Installation of Lightning Protection Systems*
- UL 96, *Lightning Protection Components*
- UL 467, *Grounding and Bonding Equipment*
- \1\ (ANSI/)UL 1449, *Standard for Surge Protective Devices*, Fourth Edition or later /1/

Ordnance facilities or locations where ordnance and explosives are handled and stored require special protective measures. Comply with the following documents for these systems:

- UFC 4-420-01, *Design: Ammunition and Explosives Storage Magazines* (DRAFT)
- NAVSEA OP-5, Volume 1, *Ammunition and Explosives Ashore*
- \1\ AFMAN 32-1065, *Grounding Systems*
- Air Force Manual (AFMAN) 91-201, *Explosive Safety Standards*
- Air Force Manual (AFMAN) 91-118, *Safety Design and Evaluation Criteria for Nuclear Weapon Systems* /1/
- Department of the Army Pamphlet 385-64, *Ammunition and Explosives Safety Standards*
- \1\ MIL-STD 188-124B, *Grounding Bonding and Shielding for Common Long Haul Tactical Communication Systems Including Ground Based Communications Electronics Facilities and Equipment* (U. S. Navy) /1/

Additional requirements associated with grounding, bonding, and shielding of communications facilities are provided in MIL-HDBK 419A, *Grounding, Bonding and Shielding for Electronic Equipment and Facilities*.

\1 Note: Ground testing of equipment is the responsibility of the equipment owner/user. **/1/**

This Page Intentionally Left Blank

CHAPTER 2 STATIC ELECTRICITY PROTECTION

2-1 STATIC GROUNDING AND BONDING REQUIREMENTS.

Identify hazardous classified locations in accordance with NFPA 70. Provide grounding and bonding for these areas in accordance with NFPA 77 to support the intended operations.

Include a listing of hazardous materials, containers, and operating units in the design, and indicate fixed operating equipment locations on the drawings. Identify portable and movable equipment requiring static electricity grounding distinctively by location and with type of grounding method each location requires.

\1

2-1.1 Bonding and Grounding Conductors.

Bonding and grounding conductors must be sturdy enough to withstand mechanical damage and must not be smaller than 6 AWG copper. For added flexibility, use braided cable or flexible bonding straps for static grounds on portable or movable equipment. Install at least two separate braided cables or flexible bonding straps on portable or movable equipment such as doors, hinged shelves, or tables, for redundancy. Flexible cables or straps have a shorter life than solid copper, especially since they must be replaced once 50% of the strands are broken. Conductors are typically uninsulated. Apply bonding for other facilities in accordance with NFPA 70 and NFPA 780. Before securing any bond, prepare for electrical continuity by removing any paint, oil, dirt, or rust on contact surfaces. If factory coatings are removed by chemicals used in the preparation process, that coating must be reapplied to protect against corrosion. A resistance reading of one ohm or less is required across bonds, to indicate continuity. **/1/**

2-1.2 Connections.

Do not connect static grounds above grade to:

- Electrical equipment grounding systems.
- Telecommunications systems grounds.
- Gas, steam, oil, hydraulic, hot water or airlines.
- Sprinkler systems.
- Any component of the lightning protection system (LPS).
- **\1** Down conductors. **/1/**

These systems must be interconnected below grade. As an exception to performing the calculations required by NFPA 780, the 6 foot (1.83 m) bonding requirement allowed by UL 96A may be used. The preferred method for reducing the potential for side-flash is to increase the separation distance between the static ground and the six items above, so that a bond is not required. The minimum size of the bonding conductor is 6 AWG copper.

\1 A static ground should never be bonded to a down conductor. It should be bonded to the building power system ground either at the service ground rod or at the main distribution panel or motor control center where the neutral bus bar and ground bus bar are bonded together.

Static bonds must be bonded only to component paths designed for static dissipation. **/1/**

2-1.3 Static Bus Bars.

A static bus typically consists of 2 inch x ¼ inch (51 mm x 6 mm) copper bars installed on the interior wall of the facility, as shown in Figure 2-1. Static bus bars must be used only for static grounding. Bus bars, especially those used in the telecommunications industry, may come with insulators, if specified when ordering. Static bus bars must be isolated from other grounding subsystems as much as possible and must be isolated when used for ordnance grounding and from lightning protection down conductors including steel columns used as the down conductor. The grounding system for the static bus bars is typically connected to the building grounding system by running at floor level on the interior until it can be routed to the exterior to the single point facility ground rod or be bonded to a ground rod and the ground rod bonded to the ground ring electrode. This configuration will allow the static bus bar to be grounded even if the ground ring electrode is broken or compromised, or requires replacement.

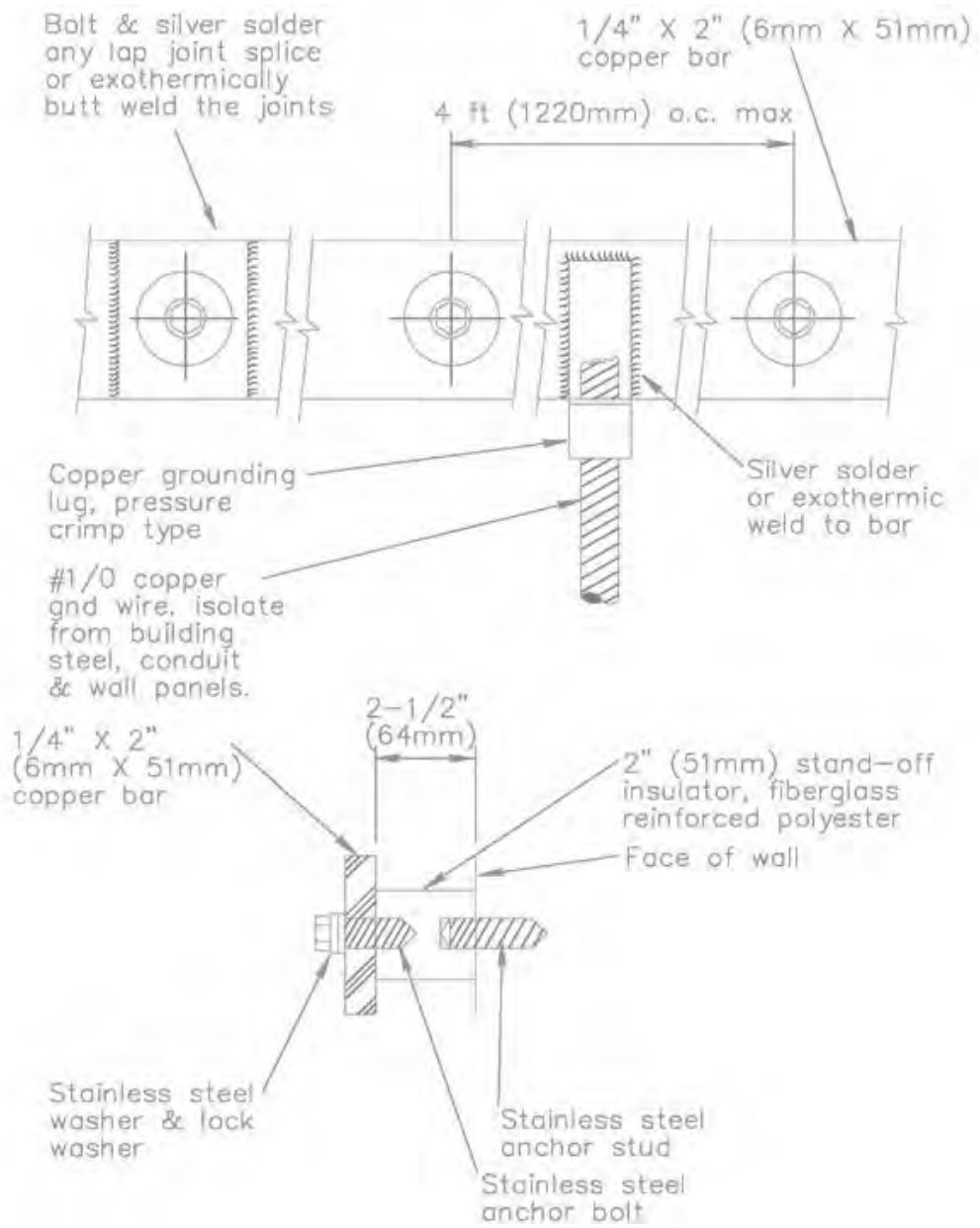
2-1.4 Resistance to Ground.

Current caused by static electricity is typically on the order of milliamperes. A resistance to ground of 10,000 ohms is more than adequate to bleed off normal static charges. All grounds used for static protection in DoD facilities, including those for aircraft and fuel tanks, must have a maximum resistance of 10,000 ohms. Any danger of electrical shock hazard caused by the 10,000 ohm value can be eliminated by proper bonding to other grounding media.

2-1.5 Ground Grab Bars.

Ground grab bars **\1** should **/1/** be installed immediately outside entrance doors to operating buildings, rooms or structures where special hazards exist. A ground grab bar consists of a length of non-corroding conductive pipe or bar which is connected to the earth electrode system (EES).

Figure 2-1 Static Bus Bar



2-2 GENERAL APPLICATIONS.

2-2.1 Conditions.

\1 This UFC does not identify all applications where static electricity protection should be provided. The electrical designer must analyze suspected potential static electrical charges and address the conductive paths that could reasonably exist between them. The following

conditions are critical examples. For other concerns such as wrist stats, gloves, or boots, contact the Electrostatic Dissipation Association (ESDA). **/1/**

- Hazardous area classifications and locations, as listed in the NFPA 70. The electrical design must incorporate the requirements of the using service relative to hazardous materials, equipment, and containers to enable the construction contractor to proceed with a full understanding of static electricity protection requirements.
- **\1** Locations where hazardous materials are handled need to be assessed on an individual basis to determine if static electricity is a problem. **/1/**
- Relocatable and portable equipment having static-electricity-generating capabilities potentially dangerous to personnel.
- Locations containing explosives or related types of materials must comply with applicable Service requirements for ordnance facilities; refer to the paragraph entitled “Key Codes and Standards.”

2-2.2 Applications.

Comply with NFPA 77, including the following types of applications:

- Spray painting operations; also apply NFPA 33.
- Conductive flooring.
- Conductive conveyor belts and V-belts.
- Humidification. If humidification is used to control static electricity discharges, daily checks are required to ensure humidity levels are maintained within specified levels.

Static electricity protection for other facilities must satisfy the requirements within this UFC. Protection for other facilities must be assessed on a project-by-project basis only. Where criteria of other Federal agencies conflict with criteria contained in this UFC, the more stringent criteria apply.

Ionization techniques are covered in NFPA 77. Ionization techniques are not to be used in hazardous areas. Radioactive ionization sources are not allowed.

2-3 SPECIFIC APPLICATIONS.

\1

2-3.1 Petroleum Oil Lubricants (POL) Facilities.

This paragraph pertains to static electricity protection for pumping, distribution, and fueling and defueling storage and handling facilities. Fueling and defueling of fixed wing aircraft on the ground is discussed in the paragraph entitled “Aircraft Parking Aprons”. Comply with UFC 3-460-01.

Impressed current type cathodic protection systems can cause voltage gradients on the surface. The aircraft requires protection from those gradients, so an isolation flange is installed. Since we are protecting aircraft and personnel from those gradients, the grounding points are required on the aircraft side of the flange.

The following items must be grounded directly to an earth electrode system (EES). Resistance to ground must not exceed 10,000 ohms.

- Installations that use a static grounding/bonding reel must ensure the resistance through the reel is 10 ohms or less. This means the resistance to ground plus the resistance of the reel must be 10 ohms or less.
- For aircraft direct fueling stations and hydrant fuel pits, locate grounds on the aircraft side of any insulating flange used for cathodic protection isolation systems. Cathodic protection systems (impressed current) can cause voltage gradients on the surface. The aircraft needs to be protected from those gradients, so an isolation flange is installed. Since we are protecting aircraft and personnel from those gradients, the grounding points need to be on the aircraft side of that flange. **/1/**

2-3.2 Hospitals.

Comply with NFPA 99 for static protection required for hospitals.

2-3.3 Aircraft Parking Aprons and Hangar Floors.

Do not use static grounds or grounding receptacles for **\1** aircraft lightning protection. **/1/**

2-3.3.1 Aircraft Parking Aprons.

2-3.3.1.1 Static Grounds.

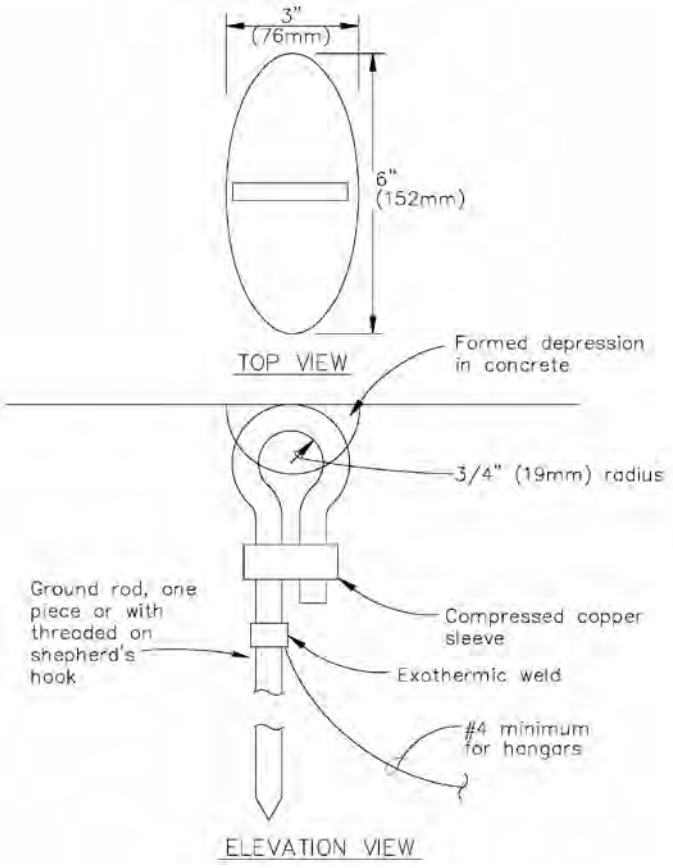
Provide static grounds with less than 10,000 ohms on aprons, in airplane parking-hydrant fueling and defueling areas, and near each hydrant pit.

- **\1** Mooring eyes/tiedowns are permitted to be used as static grounding points if criteria are met. When the dimensions of the mooring eye rebar are larger than the normal static ground clamp used by the Activity for the aircraft, determine if the Activity will utilize adapters on their clamps, or if they require a separate ground system. If a ground system is required to obtain a power ground (25 ohms), use the grounding receptacle, per Figure 2-3 with a grid arrangement as described in Section 2-3.3.2. Coordinate with Activity on whether or not the receptacle cover and ball chain are required to be removed for Foreign Objects and Debris (FOD) prevention. **/1/**

\1\ For the Air Force: Provide static grounds in concrete as illustrated in Figure 2-2, commonly called a Shepherd's Crook. **/1/**

- **\1** Static grounds may not be used as tie-downs. Tie-downs may be used as static grounds if testing indicates less than 25 ohms to ground. If tiedowns are intended to also be used as static grounds, soil conditions may require that a ground rod be installed. When a ground rod is included, it must be bonded to the tie-down bar. **/1/**

Figure 2-2 Air Force Static Grounding Point



2-3.3.1.2 Power Grounds.

If a power ground system with less than 25 ohms is required on an apron, use the grounding receptacle with grid per Figure 2-3.

2-3.3.1.3 Aircraft Fueling.

In addition to the criteria given herein, apply NFPA 407 when aircraft fueling is involved.

2-3.3.2 Aircraft Hangar Floors.

Grounding devices installed in floors are intended to serve as aircraft static and equipment grounding. A static grounding system conforming to NFPA 77 is suitable for dissipation of any aircraft static electricity to ground. However, because NFPA 70 requires a maximum of 25

ohms resistance to ground for equipment grounding, the 25-ohm requirement governs for this dual-purpose grounding system. Interconnect floor grounding systems electrodes below concrete in a grid arrangement, and interconnect to the hangar electrical service grounding system. Use a minimum of 4 AWG bare copper for interconnections. Where hangar floors are modified, extensions to grounding receptacles must remain load bearing to match original installation and the cover must be kept level with the finished floor.

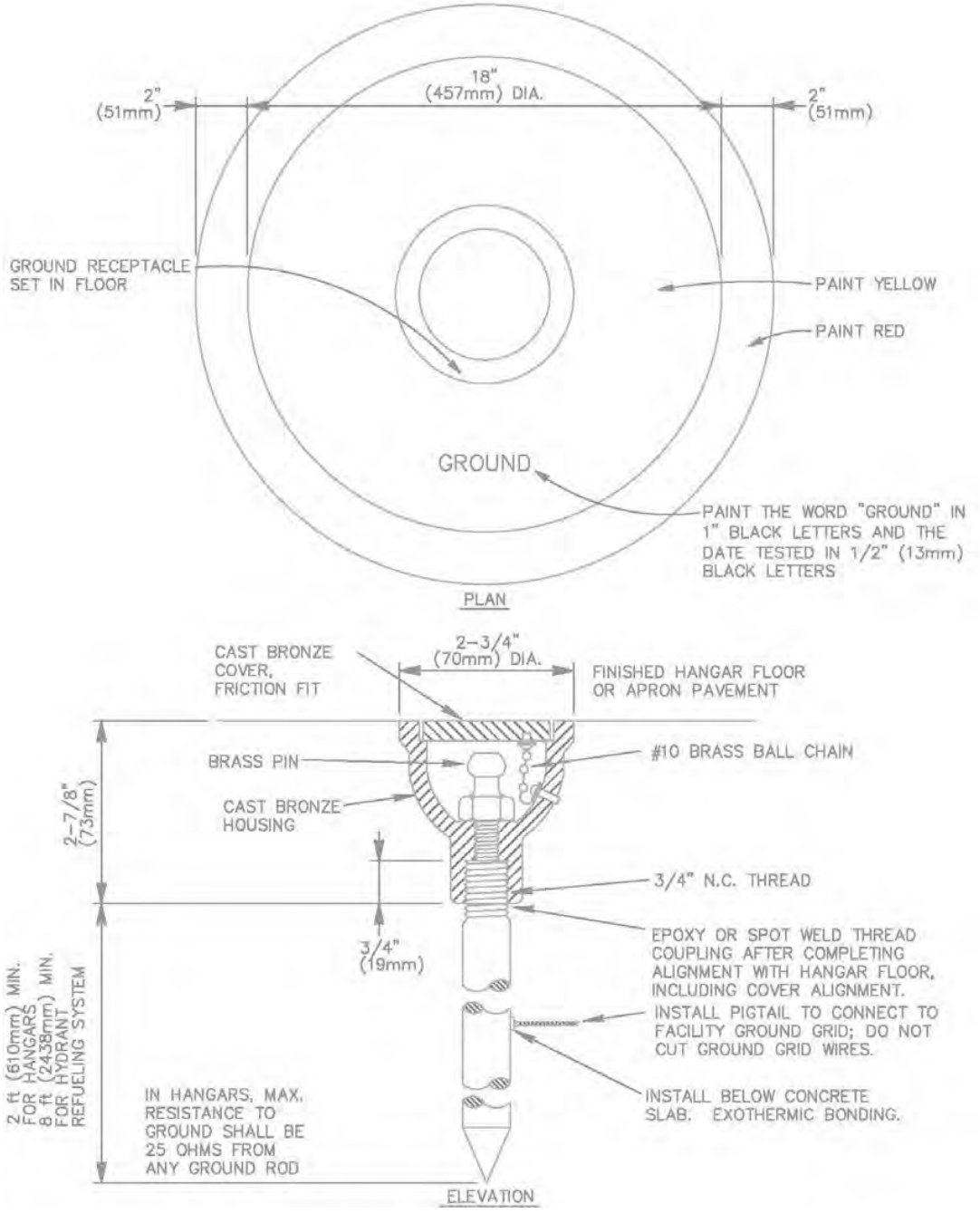
The tie-downs or grounding receptacles must be interconnected with bare copper cable. UFC 3-260-01, Appendix B, Section 11, provides guidance on layout and configuration of the grounding receptacles, relative to some aircraft. Floor layouts for receptacles must conform to the following:

- In the absence of other guidance, hangars that will be used for a specific number and type of aircraft must provide one grounding electrode for each aircraft space, approximately 10 ft (3 m) from the centerline of the aircraft space in the vicinity of one of the main landing gears.
- For general purpose hangars, provide electrodes for each aircraft space approximately 10 ft (3 m) from the centerline of the aircraft space, installed at 50 ft (15 m) intervals. Spacing of electrodes from wall lines or columns must not exceed 50 ft (15 m).
- Additional aircraft grounding guidance (operations and maintenance) is provided in MIL-HDBK-274 (AS).

2-3.3.3 Grounding Receptacle.

- Aircraft hangar floors must use a grounding receptacle as illustrated in Figure 2-3.
- If a separate ground system is required for aircraft parking aprons, use the grounding receptacle with grid as illustrated in Figure 2-3.
- **\1** Do not paint grounding receptacles.
- Receptacles with brass ball chain for cover attachment are required inside hangars.
- Receptacles within hangars may have double pin for multiple grounding. **/1/**

Figure 2-3 Grounding Receptacle



Note 1: Paint colors associated with static grounding services vary with application and service. The paint is applied directly to the hangar floor or apron pavement, and is not applied to the receptacle.

Note 2: When directed by the using activity, receptacle covers with brass ball chain shown on Figure 2-3 are not required for apron pavement areas.
\1 Note 3: Inside hangars, a grounding grid is recommended.

In general, any aircraft parked in hangar should be electrically grounded. The grounding should be done from basic aircraft structure to a low resistance ground. Grounding of the aircraft is usually done to:

- protect aircraft and personnel against hazards from lightning discharge.
- provide current return paths.
- protect personnel from shock hazard.
- prevent accumulation of static charge.

During de-fueling or refueling, the aircraft is grounded to the fuel truck. In general, the aircraft are grounded to a point where the impedance is less than 10,000 ohms referenced to earth for static grounding. For power grounding, it should be less than 10 ohms to power systems neutral. Aircraft are not grounded to the hangar structure as the external power supply, when connected, is grounded to that. **/1/**

Note 4: The above criteria will be reconciled with criteria in other UFCs so that the required criteria is located in a single location; the other UFCs and criteria documents will refer to UFC 3-575-01. In the event there is a conflict between this criteria and other criteria in another document, this criteria governs. The following documents are known to be affected by the above criteria:

Document	Title
MIL-HDBK-274A(AS)	Electrical Grounding for Aircraft Safety
UFC 3-260-01	Airfield and Heliport Planning and Design
UFC 4-211-01N	Aircraft Maintenance Hangars: Type I, Type II and Type III
UFC 4-211-02NF	Corrosion Control and Paint Finishing Hangars
UFC 4-211-02	Aircraft Corrosion Control and Paint Facilities (99% Draft – September 2011; included here to ensure the UFC is reconciled with this criteria)

This Page Intentionally Left Blank

CHAPTER 3 LIGHTNING PROTECTION SYSTEMS

3-1 DETERMINING THE REQUIREMENTS FOR LIGHTNING PROTECTION.

\1\

3-1.1 Risk Assessment.

3-1.1.1 Facilities that house explosives and critical communications facilities require lightning protection systems. For general facilities, provide a risk assessment in accordance with NFPA 780 Annex L, Section L-5, *Simplified Risk Assessment.* Summarize recommended requirements, on engineering decisions, based on experience and good engineering practice. Document reduced or enhanced requirements resulting from engineering decisions and good engineering practice, with justification for changes. Note: These assessment tools are very conservative and may not contain variables that the designer and/or the AHJ would consider in making the final decision. AHJ should be consulted during design and before written recommendation. AHJ may provide some applicable local information which could affect the installation of LPS. Depending on location, if direct strikes are not probable, and if assets are less than the cost of the LPS and its maintenance, use surge protective devices to provide protection for indirect strikes and voltage surges from other sources. SPDs will also protect against switching surges from power outages and restorations of power.

3-1.1.2 Per NFPA 780, Annex L, paragraph L.1.1 “There are some cases where the need for protection should be given serious consideration regardless of the outcome of the risk assessment. Examples are those applications where the following are factors: (1) Large crowds (2) Continuity of critical services (3) High lightning flash frequency (4) Tall isolated structure (5) Building containing explosive or flammable materials (6) Building containing irreplaceable cultural heritage.”

3-1.1.3 If, after calculations, the indication is that a LPS is “recommended,” this allows the authority having jurisdiction (AHJ) to make a decision based on local conditions, strike density, and other variables which might make an LPS necessary for one military installation where it would not be necessary for a military installation at another location, even if using the same design. Since lightning protection systems are not a one-size-fits-all, and must be truly designed anew for each facility, the NFPA 780 committee, combines Annex L with AHJ responsibilities and authorities throughout NFPA 780 to tailor the LPS to conditions that may not be the same in all situations. Consider Florida compared to North Dakota.

3-1.1.4 Even if a “required” is a result of calculation, the AHJ is still allowed to check the local conditions and variables, consider the contents, and make the final decision. We are protecting the contents of the facility/structure, not the roofs or walls. This method of decision combining Annex L with an AHJ familiar with the region of the military installation -- provides the best opportunity to “fit” the requirements to the installation without overdesign.

3-1.1.5 Decisions by the AHJ are required to be documented in the test records of the facility/structure, as future documentation. **/1/**

3-1.2 Certification of Lightning Protection Systems.

If lightning protection is required, provide an LPS in accordance with NFPA 780 criteria, using components manufactured in accordance with UL 96.

Provide certification from a commercial third-party inspection entity whose sole work is lightning protection, stating that the lightning protection system complies with NFPA 780. Third party inspection entity cannot be the system installer or the system designer.

For Army: Provide a UL Lightning Protection Inspection Master Label Certificate for each facility indicating compliance with NFPA 780.

For Navy: LPS is required for A&E facilities for DSER and Service policy and must meet NAVSEA OP-5 requirements in addition to NFPA 780. A UL Certificate is not required.

U. S. Army Corps of Engineers- and NAVFAC-managed projects for the Air Force must comply with the requirements of the Air Force; e.g., AFMAN 32-1065 and NFPA 780.

3-1.3 Additions to Existing LPS.

Projects calling for an LPS addition to an existing LPS project must consider the configuration of the final LPS in the initial design. Projects of this type must ensure the final LPS as a whole is compliant with AFMAN 32-1065 (for Air Force only) and NFPA 780 (for all services). The same third-party inspector requirements apply.

Evaluate planned facility modifications and additions, and determine if an LPS will be required or if an existing LPS will be affected by the modification/addition. The resulting LPS for the whole facility must be addressed in the planning and design stages. This may require some adjustment to the existing LPS. If the mission of a facility changes, determine if an LPS is required.

Note: Ensure that systems currently compliant with respect to lightning protection are not made noncompliant by facility modifications and additions. LPS must be considered in the design of any project for a facility that has an LPS. This includes paint projects, roofing projects, projects requiring roof penetrations, installation of new HVAC or other metallic equipment, antenna installation, or other work. Additions and modifications to the facility envelope require re-evaluation of the LPS for the completed facility as a whole. The LPS required by the addition or modification must not be a simple addition to the LPS. The LPS must be considered a single entity and must comply with requirements of a single LPS upon completion.

3-1.4 Explosives Facilities.

Facilities or locations which are used for the development, manufacturing, testing, handling, storage, inspection, holding or maintenance of ammunition or explosives are required to have lightning protection unless specific conditions are met. Provide a UL Lightning Protection Inspection Certificate for the facility. This certificate must be certified to NFPA 780, Chapter 8

and the 100 ft (30.5 m) radius rolling sphere, unless otherwise indicated by that Service; refer to the paragraph entitled “Key Codes and Standards.”

\1

3-1.4.1 Air Force Recordkeeping and Review.

3-1.4.1.1 Inspectors and testers must compile and maintain records of their inspections and tests. Records should include a sketch of the grounding and lightning protection system, showing test points and where services enter the facility. The sketch should also show the location of the probes during the ground resistance test. (Separate sketches are suggested for static, earth ground, and lightning protection systems on large complex facilities.) Sketches should capture the following:

- Date action was performed.
- Inspector's or tester’s name.
- General condition of air terminals, conductors, and other components.
- General condition of corrosion protection measures.
- Security of attachment for conductors and components.
- Resistance measurements of the various parts of the ground terminal system.
- Variations from the requirements of this UFC, citing equivalency or better.
- Discrepancies noted and corrective actions taken.
- Dates of repairs.

3-1.4.1.2 The BCE will review records for deficiencies and analyze the data for undesirable trends. If test values differ substantially from previous or original tests obtained under the same test procedure and conditions, determine the reason and make necessary repairs and document repairs.

3-1.4.1.3 Inspectors and testers will keep test and inspection records in accordance with DODD 6055.09-M-V2, *Ammunition and Explosives Safety Standards. /***1***/*

3-2 CONVENTIONAL LIGHTNING PROTECTION SYSTEMS.

Nonconventional systems, such as dissipation arrays and those using early streamer emission-type air terminals and attachments of multiple terminal points to the air terminal, are prohibited.

3-2.1 Air Terminals.

Air terminals mounted on or adjacent to equipment which is exhausting hazardous vapors must be a minimum of 60 inches (1524 mm) above the equipment to allow for the vapor to be dispersed. These air terminals require special mechanical supports per NFPA 780. **\1** Air terminals installed on “rubber” (EPDM) type roofs must use adhesive shoes with adhesive

approved by the roof manufacturer. In areas of snow and/or constant wind, ensure that a section of roofing material is first glued to the roof and then the air terminal is glued to it unless the roof manufacturer recommends another solution. This section of roofing material must be a minimum 1 ft^2 (92,900 mm^2).

A nonconductive pole may be used only when heights and structural strength permit and must be provided with metal air terminals and two bare copper down conductors not less than 1/0 AWG connected to an earth electrode. The down conductors must be placed as near as possible to 180 degrees apart and must not be run inside the pole.

For Air Force: Adhesive fasteners can be a source of high maintenance and damage to the building/structure when not installed in accordance with manufacturer's instructions and the surface properly cleaned. In lieu of adhesive fasteners, consider installing a mast or catenary system. This will minimize testing and visual inspections to buildings/structures by reducing the number of test points. It will also minimize damage to the building and LPS during storms and hurricanes. If adhesive fasteners must be used, an inspector who is familiar with installation of these adhesive fasteners must watch during the installation, and verify in writing (print name after signature) in the test records for that facility/structure that the installation was in accordance with manufacturer's instructions. Note that adhesive fasteners in desert areas may be dependable for up to 10 years. The Air Force goal would be to minimize use of air terminals, taking advantage of mast/catenary systems, to minimize maintenance, testing, repair and storm damage by up to 90%. **/1/**

3-2.2 Masts.

\1

3-2.2.1 Steel Masts

/1/

Masts of heights up to 40 ft (12.2 m) must be of single section design. When down conductors are required because metal mast thickness is less than 3/16 inches (0.1875 inches or 4.8 mm), the down conductors must be placed as near as possible to 180 degrees apart. All conductors and connections to the ground loop must be run on, and bonded to, the outside of the mast.

Wind and ice loading on the mast and on associated overhead wires must be considered during design. Provide damping in accordance with manufacturer's recommendations.

Metal mast foundation designs must take into account wind loading and ice loading. Foundations for setting metal masts must be in accordance with the following:

- Steel or aluminum, mounted by anchor bolts set in a concrete foundation poured in place. Follow manufacturer's recommendations for foundation design and type and for setting of anchor bolts.
- Steel, mounted by means of a stub set directly into a concrete foundation.
- Corrosion-resistant steel masts may be set directly into earth where soil conditions permit.

\1\

- Steel masts for a catenary system must be rated for transmission/distribution line use by the manufacturer because of the directional forces at the top of the mast.
- Steel masts for a single mast do not require transmission/distribution line rating because the force is all vertical.

3-2.2.2 Wooden Masts.

Wooden masts require air terminals and two paths to ground, as with all active (excluding fasteners) components of an LPS. A wooden mast as part of a system of masts in a catenary may use horizontal components (cross conductors (catenary)) as one or both path(s) to ground. If a cross conductor is used as one of the paths, the connection point between the air terminal and cross conductor attachment must be less than 25 ohms to ground.

Wooden masts of a catenary system must be transmission/distribution line rated (based on larger diameters at the tops and bases – this is a “CLASS” adjustment.) Example: A Class 4 pole may become a Class 3 or Class 2 pole, depending upon the pole height required to accomplish the rolling sphere area under which protection is provided by the LPS. The rolling sphere must be shown valid in a drawing based on a combination of pole heights and cross conductor heights.

Wooden masts of a mast system (one or more masts without cross conductors) do not require the larger class pole. The rolling sphere must be shown valid in a drawing based on pole heights. **/1/**

3-2.3 Joint Design.

Slip-joint design must meet the following requirements:

- Ensure overall structural integrity of the mast.
- Include a field assembly requirement to ensure a snug fit, so that joints of the mast will not loosen when subjected to vibration modes caused by wind or other means after erection.
- Be compatible with field erection requirements to facilitate ease of installation at the site.
- Have good metal-to-metal contact, so that electrical conductivity is equal to or better than the parent metal.

3-2.4 Down Conductors.

Do not install down conductors inside down spouts.

3-3 GROUNDING AND BONDING FOR LPS.

Bond equipment or subsystems into a single grounding system for the facility. Apply UFC 3-550-01 for general grounding system requirements. Include the following additional requirements for the LPS:

- When a power ground ring is required, install the ground ring in accordance with UFC 3-550-01. This will require the ring to be installed at a minimum depth of 30 inches (762 mm) rather than the minimum 18-inch (457 mm) depth required by NFPA 780.
- **\1** Terminate each down conductor to a grounding electrode located inside a test well for easy access, or to a ground ring electrode (counterpoise) dedicated to the LPS. Consider a ground rod/test well between the down conductor and counterpoise, so that if the counterpoise is cut, the down conductor remains adequately grounded. This could be more of a consideration for explosives facilities and communications facilities. If a ground ring is used, the ground ring is deemed to be associated with the LPS and thereby meets the requirements for a dedicated grounding electrode.
- In accordance with NFPA 780, facilities exceeding 75 feet (23 m) in height must be protected with Class II materials. Explosives facilities require a ground ring electrode of 1/0 copper (NFPA 780 change pending). **/1/**
- When a facility requires an additional dedicated ground ring for a catenary lightning protection system, this ring must be designated the primary ground ring. It must be installed not less than 3 ft (914 mm) beyond the first (inner or secondary) ground ring and the two ground rings must be bonded together in at least two locations.
- As an exception to performing the side flash calculations required by NFPA 780, the 6 foot (1.83 m) bonding requirement allowed by UL 96A can be used.
- Bond metal ladders to the system at both the upper and lower ends of each ladder.

\1

- Ensure that LPS ground rods (grounding electrodes) meet the size and dimensions for LPS in NFPA 780, which is 5/8” by 8’, with bottom of rod buried 10 feet below grade (top of ground rod approximately 2’ below grade). **/1/**

3-4 SURGE PROTECTION.

\1 Surge protection is required to provide protection against the high magnitudes of voltage present with indirect lightning strikes and other surges like power outages and power faults, particularly in this environment of increasing electronics. **/1/**

Provide appropriate class surge arresters at the distribution transformer supplying the facility. Provide surge protective devices for all systems identified in NFPA 780. Refer to UFC 3-520-01 for the requirements.

\1\ For Air Force: Surge protective devices must comply with the following requirements for WSAS, MSAS, and communications facilities. **/1/**

- Standard, published, minimum 10-year unlimited replacement warranty on product. Entire unit must be replaced upon detection of the failure of any mode.
- All mode (10 modes), directly connected protection elements (l-n, l-g, l-l, n-g). Direct clamping l-n and l-l is required.
- F1 polycarbonate enclosure or National Electrical Manufacturers Association (NEMA) 4 or NEMA 4X steel enclosure: Inaccessible to unqualified persons.
- Internal over-current fusing on each phase for self-protection from failed component(s) and an internal disconnect for each phase.
- Individual component level thermal fusing.
- Bi-polar protection.
- The SPD must contain continuous self-monitoring devices with indicator lamps for each mode. These may be located inside the enclosed areas such as mechanical rooms if an indicator lamp is provided in a visible area. For WSAs and MSAs, the indicator lamp should be installed in a location that can be seen from a vehicle, allowing maintenance personnel to drive through the large areas and quickly identify devices that have operated. Indicator lamps that can be seen in this way will allow maintenance personnel to determine whether a group of SPDs have operated, providing information about the circuit.
- Cable connections between a bus and SPD must be minimum No. 10 AWG for installation at main distribution panels and branch panels.
- **\1** SPDs may not be manufacturer-installed inside the service panel. The wrong panel has been known to be ordered, resulting in a long lead from the SPD to the bus, rendering the SPD useless. In addition, the SPD may not be installed inside a panel, in accordance with UFC 3-520-01, para 3-4.1.
- Visible indicators of SPD operation on the exterior of facilities. Drive-by visual inspections may be an effective means of inspecting SPDs.
- Non-modular. The entire unit must be replaced upon detection of the failure of one mode of operation. Ease of installation must not be traded for possible minimized protection levels. **/1/**

3-5 REQUIREMENTS FOR ORDINARY FACILITIES AND STRUCTURES.

3-5.1 Non-Reinforced Concrete or Wood Frame Building.

The fastener selected must be appropriate for the application and suitable for attachment to concrete or wood. Aluminum fasteners must not be mounted to concrete.

3-5.2 Reinforced Concrete Buildings.

Do not use reinforcing steel for down conductors.

\1\

3-5.3 Steel Frame Buildings.

Down conductors may not be required when air terminals are mounted on steel which is at least 3/16 inch (4.763 mm) thick and in direct contact with the ground. Steel used as structural components is typically in the form of an I-beam or other steel members. I-beams under 7/32 inch thickness do not exist according to Standard I-Beam Sizes Chart at https://amesweb.info/Profiles/Standard-Steel-I-Beam-Sizes-Chart.aspx and exceed the requirement for thickness. At the thicknesses and weights indicated in this chart, unless some kind of insulation is between joined sections, the steel is inherently continuous due to the weight of the steel. Use of steel framework in lieu of down conductors is permitted only if documentation is provided at the base of each column that the resistance to ground (ground rod or ground loop conductor, if present) at the base of the column is less than or equal to 25 ohms. Provide initial test readings between connected steel (beams and columns) components to validate the electrical continuity of the steel framework tests at less than 1 ohm at the time of construction.

3-5.3.1 Air Terminal Construction.

For areas subject to hurricanes and other areas of high winds, follow these recommendations:

a. In lieu of attaching conductors with conductor connectors, attach with strips of membrane installed by the roofing contractor. For built-up and modified bitumen membranes, use strips of modified bitumen cap sheet, approximately 9 inches wide minimum. If strips are torch-applied, avoid overheating the conductors. For single-ply membranes, use self-adhering flashing strips, approximately 9 inches wide, minimum. Start the strips approximately 3 inches from either side of the air terminal base plates. Place strips that are approximately 3 ft long, followed by a gap of approximately 3 inches.

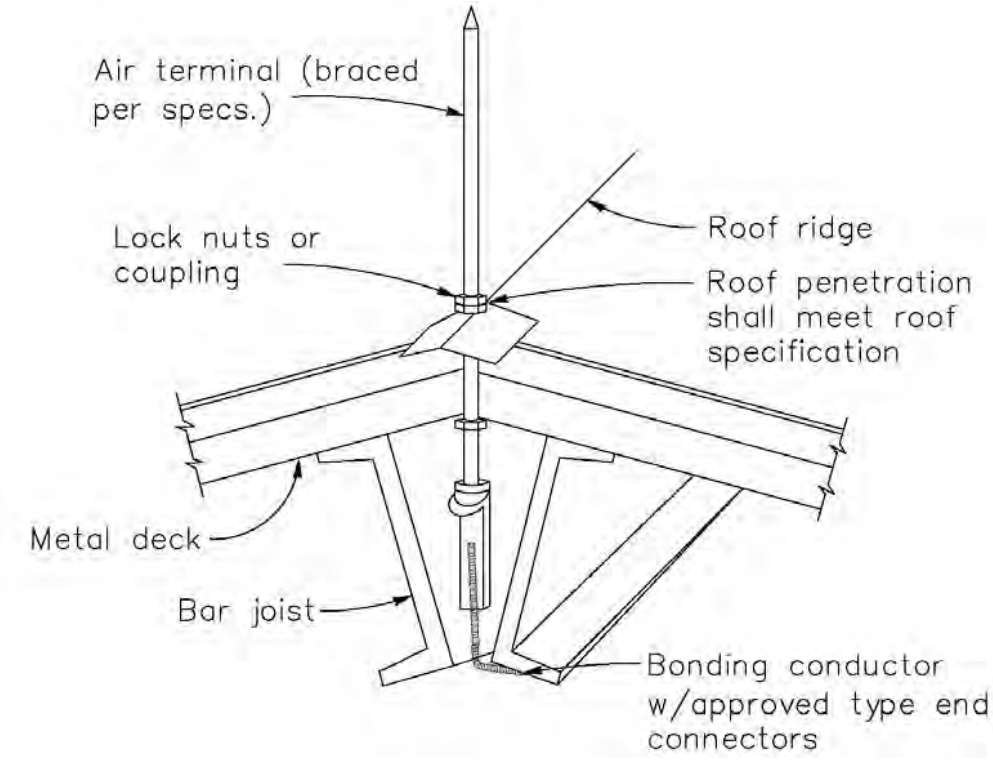
b. In lieu of pronged splice connectors, use bolted splice connectors.

For Air Force: Do not use adhesive fasteners for air terminals or down conductors. Lack of proper preparation of the surfaces and uses on surfaces unapproved by the fastener manufacturer has led to adhesive not performing to the standards of the manufacturer. Result has been costly damage to facilities.

For Air Force: If steel I-beams or round steel beams are used as structural elements with sufficient cross sectional area, no air terminals are required if structural elements are verified as continuous by conducting continuity checks on questionable joints. If those are verified to be continuous, then the remaining joints may be considered inherently bonded. Figure 3-1 would not apply to the Air Force. If steel is continuous, the entire building acts as a single air terminal. Nothing is gained by installing an air terminal on an air terminal. Protection of a sheet

metal roof or a canvas cover is not considered; the purpose of an LPS is to protect contents. A direct strike will routinely involve repair of the roof at the point of the strike. **/1/**

Figure 3-1 Typical Air Terminal Assembly Using Steel Framing As Conductor



3-5.3.2 Nonmetallic Exterior Walls with Metallic Roof.

When roof sections are insulated from each other, bond the metal roof sections together so that they are electrically continuous.

3-5.4 Metal Roof with Metal Walls.

Bond metal roof and metal walls so that they are electrically continuous.

3-5.5 Ramps and Covered Passageways.

Verify that ramps and covered passageways do not extend beyond the zone of protection of a facility. If ramps and covered passageways do extend beyond the zone of protection or if an existing structure is affected, refer to the paragraph “Determining the Requirements for Lightning Protection” to ensure that the facility certification is maintained.

3-5.5.1 Post Tension Systems.

On construction utilizing post tension systems to secure precast concrete sections, the post tension rods must not be used as a path for lightning to ground. Provide down conductors on

structures using post tension systems; down conductors must have sufficient separation from post tension rods to prevent side-flashing. Bond post tension rods to the lightning protection and grounding systems only at the base of the structure; perform this bonding in accordance with the recommendations of the post tension rod manufacturer.

\1

3-5.6 Buildings Containing Hazardous Areas.

Bond metallic objects located within hazardous areas (as defined in NFPA 70) and within 10 ft (3 m) of an LPS, to the nearest down conductor. Per NFPA 780, do not use structural members in hazardous areas as a replacement for down conductors. Bond metal frames of doors and windows located within hazardous areas to the structural column, or provide a bond from the frames to the building counterpoise system or a ground rod. Bond doors to metal frames using flexible braid-type copper conductors. Where tested resistance is less than 1 ohm between doors and their respective doorframes (this may be measured across hinges), and a test plan is maintained identifying that location, a flexible braid-type copper conductor connection is not required if the door is inherently bonded to the door frame (measure across the hinge from the door to the frame). Remove paint sufficiently so that meter probes are in contact with the steel door and steel frame. Identify the test points on LPS bonding records. **/1/**

3-5.7 Aircraft Control Navigation Aids.

Protect one-floor frame buildings which house equipment for Instrument Landing System (ILS) and Tactical Air Navigation (TACAN) facilities and other similar type structures with no fewer than two air terminals on each facility. **\1** Ideally, air terminals should be on opposite corners. **/1/**

3-5.8 Weapons Systems Electronic Facilities, Above Grade.

This section pertains to designs for the protection of radars, antennae, electronic equipment vans, launchers, missile controls, and guided missile batteries when permanently installed. Perform the following in the absence of any specific guidance from the agency in charge of the installation:

- **\1** The protection patterns must comply with NFPA 780 and consist of a mast or mast with catenary style LPS, unless specific guidance is provided for that weapons system platform. Ensure patterns are not interrupted by penetration of the pattern by any part of the LPS. **/1/**
- Locate and arrange protection equipment so as not to obstruct or interfere with the operation of any radar electronic acquisition or tracking beam.
- Where vans are clustered, ground rods for the vans must be interconnected in compliance with MIL-HDBK 419A.

Protect separate buildings containing support equipment for weapons systems electronic facilities in accordance with the building construction type.

3-5.9 Weapons Systems Electronic Facilities, Below Grade.

3-5.9.1 Protection Included with Other Protection Systems.

When an external grounding system design is included for electromagnetic pulse (EMP) protection, electromagnetic interference (EMI) shielding or other protection system, additional lightning protection is not required. Lightning protection is provided by the EMP/EMI system.

3-5.9.2 Requirements Not Included in Other Protection Systems.

When external grounding system design does not include EMP, EMI shielding, or other protection, provide a ground ring including connections to underground metallic objects, such as the following:

- Electrical conduit.
- Mechanical piping.
- Metal tanks.
- Manhole grounds.
- Missile cells or equivalent.
- Internal grounding system of control buildings and power plants.
- Metal ducts for fans.
- Tunnels.

The ground ring is not required if validated by mission operations and documented in the design analysis.

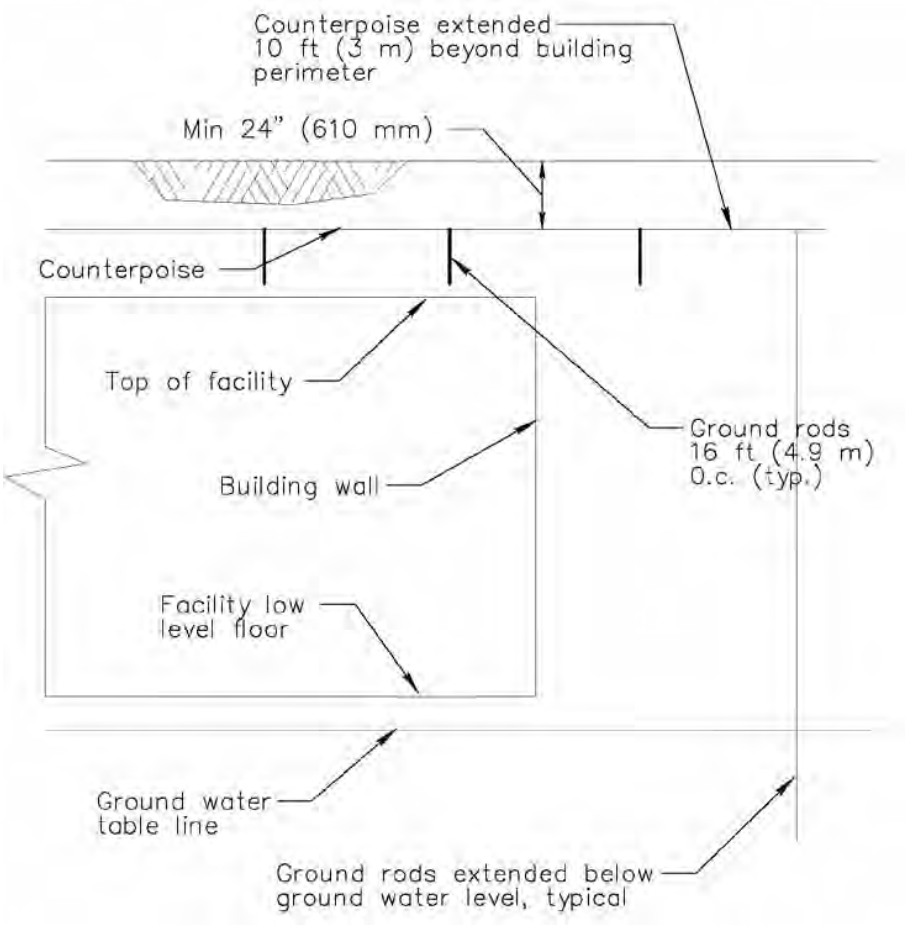
\1

3-5.9.3 Installation of Ground Ring.

Install the ground ring above each buried weapons system building, at least 18 inches (460 mm) below finished grade, and extend beyond the building perimeter not less than 3 ft (914 mm) nor more than 10 ft (3 m). Connect the ground ring to ground rods located as in Figure 3-2, and driven to a point at least 6 inches (152 mm) below normal ground water table level, where earth is available for driving. Metal equipment and metallic enclosures of equipment extending above ground must be bonded to a ground rod and the ground rod bonded to the ground ring.

For Air Force: Installation of a ground rod between the equipment/metallic enclosures and the ground ring will ensure that the ground ring is not compromised if equipment is relocated. The ground rod can remain. **/1/**

Figure 3-2 Below-Grade Weapons Systems Electronics Facilities – Ground Ring, Cross Section Elevation



\1\

3-5.10 Electrically-Controlled Target Training System.

In the absence of any specific guidance or standards for targeting systems, apply the following. Run shielded control cables (from targets to controls) or enclose the cables in metal conduit. Provide surge protection on all incoming and exiting signal and power lines in accordance with NFPA 780 and UL 1449*, Standard for Surge Protective Devices*, Fourth Edition. /1/

3-5.10.1 Control Tower.

Provide a complete protection system with at least two air terminals installed on the roof.

3-5.10.2 Target Control System.

Where each target mechanism box assembly station has a separate control relay, a lightning protection ground ring or grid is not required for protection of the down-range target area. Where such control relays are not provided, a ground ring or grid must be provided below grade above wiring in trenches to all targets.

3-5.10.3 Remote Targeting Engagement System (RTES).

Ensure the LPS and grounding comply with NFPA 780. Bonding is the more important for this unmanned system. Weapon enclosure, hatch, and stairway must be bonded to the LPS.

3-5.11 Petroleum Oil Lubricants (POL) Storage Tanks.

Where above-ground steel storage tanks are constructed on foundations of concrete or masonry, provide grounding in accordance with the grounding schedule shown in Table 3.1, regardless of tank height. Where underground steel tanks are constructed in direct contact around the entire perimeter with not less than 18 inches (458 mm) of earth cover, grounding is not required.

Table 3-1 Fuel Storage Tank Grounding Schedule

Tank Circumference (Feet)	Tank Circumference (Meters)	Ground Connections Minimum Number
200 and less	61 and less	2
201 through 300	61.2 through 91.5	3
301 through 400	91.7 through 122	4
401 through 500	122.2 through 152	5
501 through 600	152.7 through 183	6
601 through 800	183.2 through 244	7
801 and more	244.2 and more	8

\1

3-5.12 Satellite Dishes.

Locate a satellite dish within a zone of protection. One or more of the following methods must be used to determine the overall zones of protection: air terminal placements, as described in Section 4.7; the angle (geometric) method, as described in Section 4.8.2; and the rolling sphere method, as described in Section 4.8.3, all of NFPA 780.

3-5.13 Aircraft Sunshades and Shelters.

Apply NFPA 70 grounding and bonding requirements to aircraft sunshades and shelters. Obtain current guidance from each service. Additional requirements are being developed and will be included in the next change to this UFC. Obtain interim requirements from the AHJ at the associated service. Validate (document in writing and date) confirmation of additional requirements or no additional requirements as of that date.

For Air Force: If lightning protection is required and the structure is steel I-beam or round heavy beam construction and continuous to ground, air terminals are not necessary as the structural steel forms a large air terminal. Grounding will be addressed specific to each facility. Tubular steel assemblies do not meet the intent of protection against lightning. **/1/**

This Page Intentionally Left Blank

CHAPTER 4 \1\ AIR FORCE LPS INSPECTION REQUIREMENTS

4-1 EXISTING FACILITIES.

The contract for a lightning protection system project, or for any project on/to a facility which possesses a lighting protection system, requires an in-house LPS inspection and documentation of condition prior to contract start and completion. BCE repairs to existing facilities do not require a commercial third-party inspection. A BCE representative must certify the work.

4-2 NEW FACILITIES.

A third-party inspection is required for the LPS of the project, prior to acceptance of the project. The inspection must be a 100% inspection using the test point locations identified by the contractor. Test readings must either be observed by the inspector as the contractor is performing the initial tests, or test readings must be independent matching those documented by the contractor, within tenths of ohms. Note the intent is to validate integrity, not to obtain the exact reading.

4-3 ADDITIONS TO EXISTING FACILITIES.

The design and construction of LPS additions to existing facilities must ensure that the LPS, if required, joins to the existing LPS to form a single LPS, not an LPS attached to an LPS. Deviations to the existing LPS may be caused by an uncoordinated design between the existing LPS and the LPS addition. Changes may be required to the existing LPS at or near points of inter-connection for the two systems.

4-4 INSPECTIONS FOR NEW FACILITIES AND ADDITIONS TO EXISTING FACILITIES.

This final LPS project inspection must be performed by a third-party inspector (“third-party” excludes the designer or any part or subsidiary of his/her company, and the installer). whose sole work is lightning protection, or by an LPS maintenance person from the base, delegated the authority to accept LPS by the BCE in writing, by virtue of experience and training which requires an examination prior to certification of qualification.

4-5 CERTIFICATION STATEMENT.

LPS must be certified in writing by this third-party inspector as compliant with AFMAN 32-1065 and NFPA 780, prior to project acceptance. A UL certification on its own is not adequate for acceptance of any Air Force LPS project. A comprehensive inspection and compliance with this UFC and AFMAN 32-1065 is also required and UL does not inspect to these documents. Inspections may not be posted to any web site available to the public. Note that, for in-house repairs and construction, and for in-house replacement design (i.e., replacement of poles, repairs of catenary), certification by the BCE representative in lieu of a commercial third party inspection is sufficient. **/1/**

This Page Intentionally Left Blank

APPENDIX A GLOSSARY

A-1 ACRONYMS.

AFMAN	Air Force Manual
AFI	Air Force Instruction
AHJ	Authority Having Jurisdiction
AWG	American Wire Gauge
\1\ BCE	Base Civil Engineer /1/
DoD	Department of Defense
EES	earth electrode system
EMI	electromagnetic interference
EMP	electromagnetic pulse
EPDM	ethylene propylene diene monomer (m-class) rubber feet (or foot)
ft^2	foot squared or square feet
HQUSACE	Headquarters, US Army Corps of Engineers
IEEE	formerly Institute of Electrical and Electronics Engineers
in	inch, inches
ILS	instrument landing system
LPS	lightning protection system
m	meter
m^2	meter squared or square meter
mm	millimeter
NAVFAC	Naval Facilities Engineering Command
NFPA	National Fire Protection Association
POL	petroleum oil lubricants

USACE	US Army Corps of Engineers
UFC	Unified Facilities Criteria
UFGS	Unified Facilities Guide Specifications
UL	Underwriters Laboratories

A-2 DEFINITION OF TERMS.

Activity: The end use of a facility.

Approved: Acceptable to the Authority Having Jurisdiction.

Bonding: An electrical connection between an electrically conductive object and a component of a lightning protection system intended to significantly reduce potential differences created by lightning currents.

Catenary System: A lightning protection system consisting of one or more overhead wires. Each overhead wire forms a catenary between masts, and serves the function of both a strike termination device and a main conductor.

Conductor, Bonding: A conductor used for equalizing potential between metal bodies and the lightning protection subsystem.

Contractor: Person(s) doing actual construction portion of a project.

Copper Clad Steel: Steel with a coating of copper bonded on it.

Designer of Record: The engineer responsible for the actual preparation of the construction documents.

Down Conductor, Lightning: The conductor connecting the roof conductors or overhead ground wire to the earth ground subsystem.

Labeled: Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Listed: Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

Power Ground: Driven electrode at service entrance.

Qualified: Compliant with NEC/NFPA definitions and, for Air Force, experience and training meeting AFI 32-1065.

User: Facility occupants or Facility Manager.

This Page Intentionally Left Blank

APPENDIX B REFERENCES

DEPARTMENT OF DEFENSE

\1\ DODD 6055.09-M-V2, *Ammunition and Explosives Safety Standards* /1/

\1\ MIL-STD 188-124B, *Grounding Bonding and Shielding for Common Long Haul Tactical Communication Systems Including Ground Based Communications Electronics Facilities and Equipment* /1/

MIL-HDBK 274A (AS), *Military Handbook Electrical Grounding for Aircraft Safety*

MIL-HDBK 419A, *Grounding, Bonding, and Shielding for Electronic Equipment and Facilities*

AIR FORCE

\1\ AFMAN 32-1065, *Grounding Systems* /1/

\1\ Air Force Manual (AFMAN) 91-118, *Safety Design and Evaluation Criteria for Nuclear Weapon Systems* /1/

Air Force Manual (AFMAN) 91-201, *Explosive Safety Standards*

ARMY

DA Pamphlet 385-64, *Ammunition and Explosives Safety Standards*

NAVY

NAVSEA OP-5, Volume 1, *Ammunition and Explosives Safety Ashore*

UNIFIED FACILITIES CRITERIA

http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4

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

UFC 3-260-02, *Pavement Design for Airfields*

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

UFC 3-501-01, *Electrical Engineering*

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

UFC 3-550-01, *Exterior Electrical Power Distribution*

\1\ UFC 4-420-01, *Design: Ammunition and Explosives Storage Magazines* (DRAFT) /1/

UFC 4-510-01, *Design: Medical Military Facilities*

IEEE (INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS)

IEEE 142, *Recommended Practice for Grounding Industrial and Commercial Power Systems* (Green Book)

NATIONAL FIRE PROTECTION ASSOCIATION

NFPA 33, *Standard for Spray Applications Using Flammable or Combustible Materials*

NFPA 70, *National Electric Code*

NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*

NFPA 77, *Recommended Practice on Static Electricity*

NFPA 99, *Health Care Facilities Code*

NFPA 407, *Standard for Aircraft Fuel Servicing*

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

UNDERWRITER'S LABORATORIES

UL 96, *Lightning Protection Components*

UL 96A, Installation Requirements for Lightning Protection Systems

UL 467, *Grounding and Bonding Equipment*

UL 1449, *Installation for Surge Protective Devices*, Fourth Edition