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3.1 General

COMMON FEATURES

Type of Construction

- All facilities must be constructed of non-combustible materials (concrete or steel) per **UFC 3-600-01**

Mechanical Requirements

- Heated and air conditioned classroom and administration areas
- Comply with the applicable mechanical code and American Society of Heating, Refrigerating, and Air-Conditioning Engineers **(ASHRAE)** guidelines
- Additional mechanical requirements can be found in **MIL HDBK 1190**, *Facility Planning and Design Guide*

Bonding, Grounding, Surge, and Lightning Protection

- Install and maintain systems according to **AFI 32-1065**, **MIL HDBK 419**, **NFPA 780**, **DoD 6055.9-STD**, and **AFMAN 91-201**

3.1.1 Introduction

This chapter provides an overview of the standards that apply to site and facility design, facility infrastructure and support systems, and security elements common to the majority of munitions maintenance, storage, transportation, and administrative facilities. These standards are addressed in the following sections:

3.2 Site Design

3.3 Exterior Design

3.4 Interior Design

3.5 Environmental Support Systems

3.6 Telecommunications

3.7 Security Criteria

3.1.2 Common Design Standards

The following design standards apply to most munitions facilities:

1. Facilities must comply with current Air Force, Department of Defense (DoD), and industry (e.g., National Institute of Building Sciences, National Fire Protection Association, National Electric Code, etc.) construction and explosives safety standards.
2. The facility design should be simple and logical and satisfy the requirements of the project, site, and functional user.
3. The construction of the facility should be the most cost effective without compromising the architectural and engineering aspects of the facility such as flexibility, function, and character.
4. The facility must comply with all aspects of the Uniform Federal Accessibility Standard (**UFAS**) and Americans with Disabilities Act Accessibility Guidelines (**ADAAG**).
5. Structural design should be reviewed in accordance with seismic design criteria (see Section 3.3.2, "Site Design").
6. Local climate conditions should be evaluated to determine the effects of the environment on a specific type of facility (e.g., humidity control, air filtration, heating/cooling, energy consumption, insulation, degradation of building materials, etc.). Refer to **AFH 32-1163**, *Engineering Weather Data*, for additional guidance.

7. The USAF requires that projects must be capable of achieving **Leadership in Energy and Environmental Design (LEED)** minimum certification as required by the **U.S. Green Building Council** (USGBC).
8. **USAF Project Managers' Guide for Design and Construction** provides guidance on the standards for Military Construction (MILCON) projects. Major Command (MAJCOM) architectural standards and Air Force architectural standards apply to both MILCON and Operations and Maintenance (O&M) projects.

3.2 Site Design

Site design locates the facility footprint within a given parcel of land, incorporates circulation and parking, identifies infrastructure locations and landscaping requirements. Refer to **UFC 3-210-01A**, *Design: Area Planning, Site Planning, and Design*, for further information. The site design process should ensure the site meets mission requirements, addresses potential site constraints, and identifies expansion possibilities to accommodate future missions. It should address surrounding structures, natural resources (e.g., topography, drainage, and soil conditions), and climate. The following factors should be considered when planning a facility site.

Figure 3.1
Concrete Parking Apron outside Powered Trailer Maintenance Facility – Barksdale AFB, LA

3.2.1 Pavements

Design pavements to meet the functional requirements of the munitions operations. Ensure the roadbed is able to withstand the gross weight of vehicle and support equipment traffic. Design grade of apron pavements to ensure proper drainage and appropriate slope for safe vehicle access. In colder climates, consider loading and unloading operations under icy conditions. Refer to **UFC 3-230-17FA**, *Design: Drainage for Areas Other than Airfields*, for additional information. Consult base civil engineer (CE) squadron for grade design.

3.2.2 Roads

Roadways within the munitions storage area (MSA) should be designed to withstand the weight of vehicles and their loads. Designs of pavements are a site-specific consideration. Consult the base CE squadron for local guidance. Refer to **UFC 3-250-01FA**, *Design: Pavement Design for Roads, Streets, Walks, and Open Storage Areas*, for further information. Roads must also accommodate the turning radii and maneuvering requirements of the largest piece of munitions materiel-handling equipment (MMHE) assigned to the installation. Roads must have safe horizontal and vertical curves. Road system access to groups of explosives storage sites should be planned to avoid dead ends and permit emergency ingress/egress. Provide primary and alternate all-weather roads to the MSA for explosives movements. These explosives delivery routes should avoid heavily populated areas and key mission-critical facilities.

Figure 3.2
POV Parking –
McChord AFB, WA

3.2.3 Parking

Provide enough parking spaces to support the mission of the facility. Refer to **AFH 32-1084**, *Facility Requirements* for calculating parking area square footage for privately owned vehicles (POVs) and passenger-type government owned vehicles (GOVs). Special allowances are made for oversized vehicles and support equipment. Quantity-Distance (Q-D) guidance in **AFMAN 91-201**, *Explosive Safety Standards*, provide details for siting parking areas. Since POVs are not normally permitted in the MSA, the design of parking areas inside the MSA should be for GOVs and munitions handling support equipment only. When possible, trash dumpsters and recycling bins should be located adjacent to the parking area to minimize paved surfaces. Refer to **UFC 3-230-18FA**, *Design: General Provisions and Geometric Design for Roads, Streets, Walks, and Open Storage Areas,* for further information.

Accommodations for the physically challenged should be provided in accordance with **UFAS** and **ADAAG** criteria where POV parking is required.

3.2.4 Walkways

Design and build hard-surfaced walkways that complement the natural flow of pedestrian traffic to connect parking, work areas, and associated buildings within the site. The walkways to facility entrances should be a minimum 4 feet (ft) (1.2 meters (m)) wide and increase in increments of 2 ft (0.6 m) to meet local requirements. See **AFH 32-1084**. Where there is a significant change in the grade (greater than 5%), provide both steps and ramps. If required, provide sidewalk access for the physically handicapped according to **UFAS** and **ADAAG** criteria. Provide curb ramps if curbs are installed.

3.2.5 Utilities

Ascertain the availability and capacity of the existing utility systems including both the primary trunk lines and laterals to serve the facility/site. Ensure facility siting accommodates utility operations and maintenance, and that utility capacities can accommodate foreseeable capital improvements. Depending on the facility, factors to consider include water (e.g., line capacity and pressure), electricity (e.g., transformer and line capacity, service type, phasing, and purity), natural gas (e.g., delivery pressure and line capacity), wastewater (e.g., closest main, pump and line capacity), storm water drainage (e.g., detention pond capacity and discharge locations), and communications (e.g., capacity, service type). Consult the CE utilities manager and the Communications Squadron for information about capacities and connectivity of the required utilities.

3.2.6 Site Lighting

Depending on the type of facility, the security threat assessment, and the facility's intended use, install high intensity discharge (HID) security lighting. Follow the recommendations of the **Illuminating Engineering Society's (IES) Illuminance Selection Procedures** to establish appropriate foot-candle (meter-candle) illumination levels for the site. Photosensitive sensors should be used to help achieve energy-efficiency. Security Forces shall be consulted on the lighting plan to ensure it adequately accommodates security surveillance.

3.2.7 Site Signage

Site signage should comply with the installation standards and **UFC 3-120-1**, *Air Force Sign Standard*. This document contains guidelines for layout, construction, and placement of signs at the site. Additional signage requirements exist in **AFMAN 91-201**.

Figure 3.3
Explosives/Hazard Symbol Signage – McChord AFB, WA

3.2.8 Landscaping Design

Consult the **USAF Landscape Design Guide** when incorporating a landscape scheme. Use low maintenance, drought tolerant, native plants. The use of regionally appropriate landscaping techniques is extremely important on igloo and barricade walls to minimize the potential erosion of these sloped areas, thereby preserving their safety qualities in the event of an explosion. Avoid creating terrorist concealment opportunities in the landscape design. Refer to **USAF Master Landscape Construction Specifications**.

Figure 3.4
Landscape at Weapons and Release Systems Shop – Cannon AFB, NM

3.2.9 Grading, Soils, and Hydrology

Natural environmental factors such as flood potential, soils, shrink-swell, topography, slope, etc should be considered during the design process. A grading plan that maintains a natural drainage pattern for the site and directs site flows towards the existing drainage system in the area should be prepared. Provide an appropriate surface drainage system to prevent erosion and flooding. Where required, provide for velocity reduction, on-site water detention, and erosion prevention.

3.2.10 Site Expansion or Change of Facility Mission

Flexibility should be built into the site design to allow for future expansion of the facility due to mission changes. A future change in facility mission may require a change of the CE Real Property Category Code as well as create Q-D violations. A new explosives site plan (ESP) may be required.

3.2.11 MSA Smoking Areas

If the smoking area is within the MSA, follow the guidance contained in **AFMAN 91-201**. The smoking area should be sited to comply with explosives and fire safety requirements, with a minimum separation distance of 50 ft (15.2 m) from an explosives location.

3.2.12 Electromagnetic Radiation (EMR) Hazards

Contact the installation's Weapons Safety Manager (WSM), base communication squadron, and radiation safety officer to pinpoint the EMR emitter sources around the planned site (e.g., utility lines, radio/communication antennas, etc.) and determine their impact on electro-explosive devices. Consider the sensitivity of the munitions, packaging, configuration of the leads, and the power density of the EMR source. Calculate the factors and site the facility according to the safe separation distance guidelines in **DoD 6055.9-STD**, *DoD Ammunition and Explosives Safety Standards* and **AFMAN 91-201**. EMR hazards should also be considered when determining explosives movement routes.

3.2.13 Flammable/Combustible Materials

Figure 3.5
Exterior Elevations Employ Non-combustible Materials – Munitions Maintenance Facility – Cannon AFB, NM

If the projected munitions facility requires a separate flammable or combustible materials storage site, locate the site at least 50 ft (15.2 m) away from the planned facility. Contact the Base Ground Safety representative for further assistance in determining flammable or combustible storage facility requirements.

Do not use combustible materials in construction of the exterior of facilities within the MSA.

Additional flammable or combustible storage information is contained in **AFOSH 91-501**, *Air Force Consolidated Occupational Safety Standard*, **National Fire Protection Agency (NFPA) 30**, *Flammable and Combustible Liquid Code*, and **Technical Order (TO) 42A2-1-4**, *Storage Control of Organic Coating Materials (Paints and Allied Materials)*.

3.2.14 Fire Prevention/Control

Maintain a 50 ft (15.2-m) firebreak around the explosives facility when environmental and security factors allow. Design firebreaks to slow the spread of fire if grasses or ground cover are used for erosion control on (i.e., igloos) or near facilities. Ensure vegetation is maintained to reduce fire potential. An adequate supply of water and pressure should be available to suppress fires in accordance with **AFMAN 91-201**.

3.2.15 Petroleum, Oil, and Lubricant (POL) Storage

If the planned munitions facility requires POL support, such as fuel tanks for filling vehicles and support equipment, contact the base WSM to determine the storage tank location based on the facility mission requirements. The proper separation between the facility and the storage tank must be maintained in accordance with **DoD 6055.9-STD**, **AFMAN 91-201**, and **NFPA 30**. Storage tanks located above ground must comply with local, state, and federal environmental requirements and **NFPA 30**. They must also comply with **AFI 32-7044**, *Storage Tank Compliance*.

3.3 Exterior/Structural Design for Facilities

The exterior design should reflect the functional requirements of the mission planned for the facility and base-specific requirements for materials and structural design.

Figure 3.6
Steel-constructed K-span – Above Ground Magazine – Cannon AFB, NM

Unique mission requirements may need special architectural attention (e.g., apron load strength, lighting requirements for night operations, security enhancements, door size, etc.). Existing pre-approved Department of Defense Explosives Safety Board (DDESB) design drawings (listed in Technical Paper Number 15, *Approved Protective Construction*) should be reviewed for their appropriate application to similar facility functional requirements. Specific design and construction criteria for the facility requirements must be established before the project concept phase to provide the basic framework for the design.

The Air Force Center for Environmental Excellence (AFCEE) has provided an excellent tool for CE and contractors to develop architectural compatibility for the project. Additional information on this tool is available in the **Air Force Architectural Compatibility Guide** located at the AFCEE web site.

3.3.1 Exterior Materials and Methods

While certain building materials are required for safety, the base architectural standards will provide guidance on the type of exterior materials and local methods of construction. Building materials and finishes that are functional, durable, and easy to maintain should be selected. All facilities shall be constructed of non-combustible materials per **AFMAN 91-201**.

Consider recycled materials for use in construction using the Environmental Protection Agency (EPA) guidelines. The recycle guideline list changes every other year when the EPA adds new items. For the current list of recycle items, go the **EPA** web site. Refer to **AFI 32-7080**, *Pollution Prevention Program*, and the **Guide to Green Purchasing** for more information on using recycled materials.

Seismic Criteria References

Army TI 809-4, *Seismic Design for Buildings*

AFMAN 88-3, Chapter 13 (Army TM 5-809-10), *Seismic Design for Buildings*

ETL 00-5, *Seismic Design for Buildings and Other Structures*

AFMAN 32-1050(I), *Seismic Design Guidelines for Upgrading Existing Buildings*

TM 5-1300/AFR 88-22, *Structures to Resist the Effect of Accidental Explosions*

UFC 1-200-01, *Design: General Building Requirements*

Figure 3.7
Frangible Roof Design – Multi-cubicle Magazine Storage Facility - Langley AFB, VA

Figure 3.8
Facility Signage – McChord AFB, WA

3.3.2 Structural Design

Consider a variety of systems (e.g., steel frame, reinforced concrete, etc.) for the project and select the system that satisfies the facility's current requirement, provides for future expansion and flexibility, and fulfills architectural compatibility standards.

The design and construction methods must be suitable for a permanent facility conform to current DoD, Air Force, and industry explosives safety standards; and must protect against seismic events and local weather conditions at the site. (See Seismic Criteria textbox in margin.) Use DDESB pre-approved facility designs whenever possible. "Best in class" facility designs are provided in Chapter 4, "Design Standards."

If required, a seismic evaluation of the site will be performed. Use DDESB pre-approved facility designs and structural systems whenever possible. A comprehensive submittal to DDESB is required for new facility designs. For more information on Structural Design, refer to **UFC 3-310-01**, *Design: Load Assumptions for Buildings* and **UFC 3-340-01**, *Design: Design and Analysis of Hardened Structures to Conventional Weapons Effects*.

3.3.3 Roofs

Frangible roof structures should be incorporated to vent an internal explosion upward and minimize large fragments. Refer to **TM 5-1300/AFR 88-22** for details on proper construction of a munitions facility. Roof design should also consider local weather conditions (e.g., snow loading, wind, etc.). Refer to **UFC 3-190-04FA**, *Design: Roofing and Waterproofing*.

3.3.4 Windows

Windows in facilities within the explosives clear zone should not face other buildings where explosives are manufactured, processed, stored, or handled. Windows in facilities within the explosives clear zone must have shard-resistant protection (e.g., laminated glass, mylar film, explosive-proof glass, blast curtains, etc.). Additionally, windows must comply with Anti-Terrorism/Force Protection (AT/FP) requirements if the facility is considered inhabited (11 or more personnel routinely working or present in the facility). AT/FP protection criteria can be found in the **U.S. Air Force Installation Protection Guide**.

3.3.5 Facility Signage

Facility signage (e.g., building number and identification, fire/hazard symbols) must follow the base design standards and the guidelines contained in **UFC 3-120** and **AFMAN 91-201**.

3.3.6 Lightning Protection System (LPS)

A LPS is required for all munitions facilities. The LPS will be designed to intercept lightning at a 100 ft (30 m) or less striking distance. For most munitions facilities, the design drawing provides specific requirements for installing LPS. Refer to **DoD 6055.9-STD**, **AFMAN 91-201** and **NFPA 780**, *Standards for the Installation of Lightning Protection Systems*, for additional LPS protection information.

In overseas locations, refer to the Host Nation Program Management Office (PMO) liaison for LPS requirements. Many host nation requirements exceed U.S. design criteria. In this case, the more stringent requirements shall be followed.

Figure 3.9
LPS (Catenary System) – Integrated Maintenance Facility - Barksdale AFB, LA

3.3.7 Grounding Systems

Based on the facility's mission requirements, install a system that will eliminate or reduce the hazards of static electricity. The system must meet a resistance of 25 ohms or less. The system may be tied into the facility's LPS or structural members for all facilities handling, processing, or storing explosives. **AFI 32-1065**, *Grounding Systems*, and **AFMAN 91-201** for more information on grounding systems requirements.

Figure 3.10
Grounding System Inside Flight Line Holding Facility - McChord AFB, WA

3.3.8 Bonding

To prevent lightning penetration into the facility, bond all metallic objects entering the structure to the LPS. Resistance to any metal object bonded to the LPS will not exceed one ohm. Material used for the bond must be compatible with the metallic mass and down conductor to prevent corrosion. Bond the LPS to all grounding systems at the counterpoise or ground rod outside the facility.

3.3.9 Cathodic Protection (Corrosion Control)

Cathodic protection may be required on facilities in areas where galvanic action occurs due to the soil composition. Ferrous materials should be protected from corrosion by providing coating, wrapping, cathodic protection, or isolation of dissimilar materials. For additional corrosion control guidance and related web links, refer to the Air Force Civil Engineering Support Agency (AFCESA) **Corrosion Control Program** and **UFC 3-570-02N**, *Design: Electrical Engineering Cathodic Protection*.

3.4 Interior Design

Figure 3.11
Interior Wall Finish in Munitions Administration Facility - Barksdale AFB, LA

The interior features of the facility should be integrated with the architectural design and should meet future mission and functional user requirements. If applicable, munitions facilities must meet the requirements of **UFAS** and **ADAAG** including accessibility to and from work spaces, accessibility inside restrooms, access to the facility, and fire alarm notification in the form of audio and visual strobes in work spaces, restrooms, and storage rooms. The following elements should be reviewed when designing the interior of a munitions facility. Refer to the **Air Force Interior Design Guidelines** for additional guidance on interior design standards and criteria.

3.4.1 Interior Surface

General guidelines for interior surfaces are as follows.

1. Non-combustible materials should be used as much as possible for interior surfaces in accordance with **UFC 3-600-01**, *Design: Fire Protection Engineering for Facilities*, **DoD 6055.9-STD**, and **AFMAN 91-201**. If it is necessary to use combustible material in the interior of a munitions facility, treat or cover the surfaces with a fire-retardant material as recommended by the Base Fire Marshall.

2. Interior surfaces (ceilings, walls and floors) where explosives are handled, inspected, maintained, or stored must be smooth and free of cracks and crevices.

3. Provide a pleasing color scheme in inhabited areas using accents or materials that are easily maintained or changed (e.g., accent tiles, trim and/or door paint, signage).

3.4.2 Ceilings

The ceiling design must take into account the facility's security, environmental, and maintenance requirements.

Figure 3.12
Chemical-resistant Urethane on a Concrete Floor – Munitions Loading Crew Training Facility - Luke AFB, AZ

3.4.3 Floor Finishes

The following floor treatments should be considered when designing a munitions facility.

1. A concrete subfloor should be used in locations where explosives are handled, maintained, inspected, or stored.

2. Where finished floors are required (application of a coating or other finishing material to the concrete floor), provide static free surfaces to mitigate the potential of a buildup of static electricity that could cause a fire or inadvertently initiate an electro-explosives device (EED). Non-sparking floors must be smooth

and free of cracks and wrinkles. Non-asbestos resilient floor tile should be considered as a primary floor finish for high foot traffic areas such as entrances, corridors, and hallways.

3. Carpeted floor finishes should be non-static and will only be used in special areas where deemed appropriate (e.g., offices, training classrooms, munitions control rooms, administration areas, etc.) and where additional acoustical treatment is a critical requirement. For the latest guidance on carpets, refer to *Engineering Technical Letter 00-6* **(ETL 00-6)**, *Air Force Carpet Standards*, and the **USAF Interior Design Guidelines**.

3.4.4 Walls

The following guidance should be considered in wall design.

1. Exposed concrete walls are acceptable in unoccupied areas, operating bcations, storage facilities, or as substantial dividing walls. They are not acceptable as an interior wall finish in occupied areas such as administrative, training, and office locations.

2. A durable, textured finish should be provided in inhabited areas.

3. Use a vinyl covering or similar material on walls that are susceptible to mold and moisture intrusion due to climate, location, or operations in the room(s).

4. When paint is used, apply semi-gloss or low sheen paint to the walls. Only apply high gloss paint for trim, safety markings, restrooms, or similar application.

5. Ceiling paint should maximize reflectivity to enhance interior lighting.

6. Walls should be designed to prevent the spread of fire from one area to another in the facility. Firewalls should be constructed according to **UFC 3-600-01**, *Fire Protection Engineering for Facilities* and **AFMAN 91-201**. Openings in the firewall should comply with **NFPA 80**, *Standards for Fire Doors and Windows*.

7. When necessary to conduct more than one explosives operation within a facility, the operations must be arranged to provide a minimum of intraline (IL) protection by distance or equivalent protection. The goal of IL distance is to prevent propagation of other explosives within the facility in the event of an inadvertent explosives accident. If separation distance is not possible, substantial dividing walls of 12 in (30 mm) reinforced concrete walls rated at 2,500 pounds per square inch (psig) (17,170 kilo

pascals (kPa)) between work bays may provide the required level of protection. Bear in mind properly applied distances and substantial dividing walls may not prevent personnel injury in the event of an explosives mishap. Refer to **DoD 6055.9-STD**, **AFMAN 91-201**, **TM 5-1300/AFR 88-22**, and your servicing MAJCOM to obtain guidance in determining the protective wall thickness or distance between operations to meet IL distance criteria and the proper stand-off distance for conducting concurrent operations.

3.4.5 Blast Doors

Blast doors function to separate explosives work or storage spaces. The doors must only be used where high explosives are involved and protection of personnel and high-value, non-explosives equipment, or preventing propagation, is desired. Blast doors are not installed as a matter of convenience in the facility but are used for operational necessity. Refer to **DoD 6055.9-STD** and **TM 5-1300/AFR 88-22** to provide additional details for calculating the design factors needed for blast doors.

3.4.6 Window Treatment

Window tinting functions to reduce the glare and solar radiation penetration into the facility. These treatments should be provided in climates where the sun generates substantial glare or heat. Blackout-lined drapes or blackout blinds/shades for windows should be used in training rooms. If the facility is located within the explosives clear zone, the windows may also need to have shard-resistant properties to protect personnel from flying glass caused by the effects of overpressure from an explosive force. See Section 3.3.4, "Windows" for further information about window treatment.

3.4.7 Lighting

Lighting levels should be designed to accommodate the functions performed; higher lighting levels are required for detailed work and lower levels are required for general areas. The task lighting, special task lighting, and general lighting needs of the facility determine the maximum illumination (as measured in foot candles) required within the facility. The foot-candles needed in a munitions storage location may be much less than what is required in an operating location where intricate assembly work is being performed.

Normally, **Underwriters Laboratories (UL)**)-approved lighting will suffice for the majority of facilities. However, explosion-proof lighting will be required if Class I explosive vapors or Class II explosive dust will be present at the operating or storage location. The functional user should be consulted for additional project lighting requirements. Refer to the "*Additional Lighting Resources*" textbox in the margin for additional guidance.

Additional Lighting References

Air Force Interior Design Guidelines. Aids in planning facility lighting requirements

DoD 6055.9-STD and **AFMAN 91-201**. Describe explosives safety standards and some potential special lighting requirements

National Electric Code. Contains sources to obtain general information on wiring and lighting needs

Illuminating Engineering Society. Allows users to purchase publications relating to lighting needs

NFPA 101, *Life Safety Code*. Standards to calculate the project lighting requirements

Figure 3.13
Interior Lighting in Weapons and Release Systems Shop - Langley AFB, VA

The base bioenvironmental function can assist in determining the proper illumination requirements, or quantify existing deficiencies by performing lighting surveys.

3.4.8 Interior Facility Signage

Interior signs include, but are not limited to, exit signs, directional arrows, security warnings, fire fighting equipment location, etc. All interior signage must comply with the installation signage program and **UFC 3-120-1**, **AFMAN 91-201**, **UFAS**, and **ADAAG**, as applicable.

3.4.9 Restrooms

The occupancy level for the planned facility determines the required number and type of restroom facilities. Small facilities may have one unisex restroom; large facilities, or facilities with a high occupant level, should have separate restroom facilities. One shower and a locker room for each gender should be provided in facilities where the facility is utilized 24 hours per day or where the work environment requires such facilities. Lavatories should be designed with full-width counter tops that are wall-secured on three sides or sinks mounted in cabinet structures. All mirrors shall be directly mounted to the wall.

The floor should be covered with either non-skid ceramic or porcelain paver tiles with epoxy grout. The walls should be non-porous ceramic wall tiles or painted gypsum wallboard from the floor to the ceiling with a 4 in (98 mm) splashguard. Proper lighting, ventilation, and electrical outlets should comply with current industry standards.

3.4.10 Furniture Considerations

Consult the functional user to determine furniture requirements. Refer to the **Air Force Interior Design Guidelines** for assistance in planning the facility furniture layout. "Closed-wall or cubicle" offices should measure at least 10 ft x 10 ft (3 m x 3 m) in order to arrange furniture in a functional manner.

3.4.11 Pedestrian Egress Doors

Provide at least two exits out of each operating room or building containing explosives, with the egress routes free of obstructions. Doors should be panel- or flush-type construction, not less than 36 in wide (0.9 m) by 80 in (2 m) high, and should open outward. If vision panels are a necessary component of the door, shard-resistant glass should be used. Shatter-resistant glazing with acrylic plastic or equivalent material is recommended. The window frame or sash must maintain sufficient strength to retain the panel in the door in the event of an explosion. Door closing mechanisms should include dead bolt panic hardware that cannot be opened from the outside. Refer to the **American National Standards Institute (ANSI) Safety Code A156.3**, *Building Exits*, **NFPA**, and

applicable local and/or uniform building codes to construct emergency exits and fire escapes. See Section 3.5.4, "Fire Protection and Life Safety" for additional information on egress door locations.

Figure 3.14
HVAC System - Surveillance and Inspection Shop - Langley AFB, VA

3.5 Environmental Support Systems

There are several key facility environmental support services (i.e., mechanical, electrical, plumbing, fire protection, and energy conservation controls) that interact with each other. The layout of the requirements must be integrated to produce a total environmental services design. Both mission efficiencies and utility effectiveness must be taken into account. The correlation of the design for each environmental service should be done during all stages of the facility design. This becomes important when selecting the proper environmental system to support the intended facility mission requirements based on user input for the project.

The items contained in the following paragraphs will provide a general list of environmental support systems that must be reviewed to ensure all design components have been considered for the project. Specific direction related to unique environmental system support requirements is in Chapter 4, "Design Standards" of this guide.

3.5.1 Mechanical Support Systems

3.5.1.1 Heating, Ventilation, and Air Conditioning (HVAC)

The **HVAC** design must comply with the guidelines in **MIL HDBK 1190**, *Facility Planning and Design Guide.* Refer to **ETL 94-4**, *Energy Usage Criteria for Facilities in the Military Construction Program.*

The system must comply with **ETL 01-1**, *Reliability and Maintainability (R&M) Design Checklist*, criteria, as HVAC maintenance is critical to the quality of life of the occupants of the facility.

HVAC units should be located within a designated mechanical room/closet whenever feasible to ensure that filters, controls, drain pans, condensate piping, control valves, and coils are easily accessible for servicing and cleaning. For large HVAC systems, roof mounting or ground-level units may be used if screened. Condensate piping should be provided, equipped with traps and threaded clean outs at the unit. The design must include minimum clearances for maintenance. The mechanical room/closet must have a locking door that opens directly to the exterior for access by base CE.

A central ventilation system should supply conditioned air to each office space and munitions work bay when needed. If the possibility fumes may reenter the system and contaminate the air in other parts of the

Additional Mechanical Support References

NFPA 70, *National Electric Code*

NFPA 101, *Life Safety Code*

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

AFJMAN 32-1083, *Electrical Interior Code*

AFI 32-1065, *Grounding Systems*

DoD 6055.9-STD and **AFMAN 91-201**, *DoD and Air Force Explosives Safety Standards*

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

AFCESA Electrical Program

ETL 90-06, *Electrical System Grounding, Static Grounding and Lightning*

building, separate ventilation systems may be required. The system should meet conditioned air requirements outlined in **ASHRAE Standard 62**, *Ventilation for Acceptable Indoor Air Quality*.

3.5.1.2 Temperature Controls

The HVAC equipment should be controlled via a direct digital control (DDC) system. Guidance is provided in **ETL 86-16**, *Direct Digital Control of Heating, Ventilation, and Air Conditioning Systems*, for planning DDC systems.

3.5.1.3 Restroom Exhaust

The restrooms should be equipped with an individual or central exhaust system, directly vented, with a switched exhaust fan.

3.5.2 Electrical Design

The electrical design should be based on maximum occupancy for the facility and the projected operational loads. The design should include electrical distribution equipment, data fax ports, fire detection and annunciation, emergency and egress lighting, interior and exterior lighting, and receptacles and grounding plans. Facility designs must include all electrical equipment, items, device controls, and loads. Special power requirements may be needed as listed in Chapter 4, "Design Standards" for test equipment (e.g., 400 hertz (Hz), 3-Phase, etc.). A high-quality converter is required to ensure facilities have a clean, non-fluctuating, power source.

Cables or conduits must be placed underground through shielded cables or in metallic conduits for at least 50 ft (15.2 m) before entering an explosives facility (except licensed explosives facilities such as the weapons and release shop and loading crew training facility).

Refer to **DoD 6055.9-STD**, **AFMAN 91-201**, and **MIL HDBK 419A**, *Grounding, Bonding, and Shielding for Electronic Equipment and Facilities*, for grounding, bonding, and surge protection guidance.

3.5.2.1 Lighting

Interior lighting that meets Energy Star program standards should be used whenever feasible. Refer to the **Energy Star** web site for a product list. Light fixture installations should comply with the criteria in **UFC 3-600-01** and **NFPA 70**. Use **NFPA 70**, **NFPA 101**, and the **IES Lighting Handbook** for lighting calculations. Normally, **UL**-approved lighting will suffice for the majority of facilities. However, explosion-proof lighting will be required if Class I explosive vapors or Class II explosive dust will be present at the operating location.

3.5.2.2 Power Supply

The power supply should be designed to accommodate 130 percent of the load planned for the facility. Continental United States (CONUS) and, wherever possible, overseas locations, require standard 60-Hz

Additional Electrical References

NFPA 70, *National Electric Code*

NFPA 101, *Life Safety Code*

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

AFJMAN 32-1083, *Electrical Interior Code*

AFI 32-1065, *Grounding Systems*

DoD 6055.9-STD and **AFMAN 91-201**, DoD and Air Force Explosives Safety Standards

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

AFCESA Electrical Program

ETL 90-06, *Electrical System Grounding, Static Grounding and Lightning Protection*

frequency for all possible loads. This eliminates the use of individual power converters. If 60 Hz power is not available at overseas locations, comply with local code requirements and provide 220 volts alternating current (VAC)/230 VAC duplex power outlets, in addition to 115 VAC. For unique power supply requirements, refer to Chapter 4, "Design Standards," of this guide. **Designers must always verify local electrical conditions at OCONUS locations before starting the electrical design phase of the project.**

3.5.2.3 Emergency Generator

Administrative and munitions operating facilities require emergency power. The rationale for this requirement is based upon the need to preserve critical information on accountability and munitions testing systems. For those munitions facilities that require emergency power, provide a diesel generator in accordance with (IAW) **AFI 32-1062**, *Electrical Power Plants and Generators*, and **AFI 32-1063**, *Electrical Power Systems.*

Emergency generators should provide a constant power source for critical services (e.g., computers, radios, test equipment, etc.), life safety, and intrusion detection systems. The **Defense Transportation Regulation, Chapter 205**, requires the generator and fuel source supplying the Vehicle Secure Parking Area be secured and locked. Generator fuel storage must comply with Q-D criteria in **DoD 6055.9-STD** and **AFMAN 91-201** explosives safety standards.

3.5.2.4 Uninterrupted Power Supply (UPS)

If authorized by **AFH 32-1084** or other regulation or technical order, a UPS should be installed in conjunction with the facility power system(s). The UPS should supply a minimum of 15-30 minutes of backup power to supported equipment to permit completion of tasks or proper shutdown of equipment.

3.5.2.5 Lightning Protection System (LPS)

An LPS is required for munitions facilities (e.g., operating locations, storage magazines, loading crew training facilities, weapons and release systems shops, critical administrative facilities, etc.). An LPS should be designed to intercept lightning at a 100 ft (30.5 m) or less striking distance from munitions or other critical resources. Munitions facilities design drawings must specify LPS requirements. Refer to **DoD 6055.9-STD**, **AFMAN 91-201**, the **Lightning Protection Institute** web site, **ETL 90-06**, *Electrical System Grounding, Static Grounding, and Lightning Protection,* and **NFPA 780** for additional LPS protection information. The LPS design must be submitted to the DDESB with the facility design for approval prior to construction per **AFMAN 91-201**.

Figure 3.15
Explosive-proof Lighting in Flight Line Holding Facility - McChord AFB, WA

In CONUS, **AFMAN 91-201** and **NFPA 780** requirements will be used as the minimum acceptable standard for LPS. Many host nation requirements exceed United States design criteria. In overseas locations,

refer to the Host Nation Program Management Office (PMO) liaison for LPS requirements.

3.5.2.6 Grounding Systems

If authorized by **AFMAN 91-201** or other regulation or technical order, a grounding system must be installed which meets a resistance of 25 ohms or less IAW **AFI 32-1065**. The grounding system may be connected to the LPS or structural members in facilities handling, processing, or storing explosives. The grounding system design must be submitted with the facility design to the DDESB for approval prior to construction per **AFMAN 91-201**.

Figure 3.16
Grounding System Inside Flight Line Holding Facility - McChord AFB, WA

3.5.2.7 Bonding

To prevent lightning discharges from penetrating the facility, all metallic objects entering the structure should be bonded to the LPS, with resistance readings not to exceed one ohm. The bonding material should be compatible with the metallic mass and down conductor to prevent corrosion. The LPS should be bonded to all grounding systems at the counterpoise or ground rod outside the facility.

3.5.2.8 Surge Protection

Surge protection should be installed on external power, communication, intrusion detection system, and utility lines to prevent transient voltages from entering the facility. Lightning arrestors, surge arrestors, surge protectors, surge suppressors, transient power suppressors, or isolation transformers can be used to help mitigate the flow of transient voltage into a facility. For more information on surge protection, refer to Institute of Electrical and Electronic Engineers (IEEE) Emerald Book, **ANSI/IEEE STD 1100**, *IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment* and **NFPA 780**.

3.5.3 Plumbing

Plumbing may be required to provide domestic hot and cold water, sanitary sewer and storm drainage, propane or natural gas piping, steam or hot water piping, floor drains, miscellaneous plumbing fixtures, and chilled water to support the facility's mission requirements. For further plumbing information, visit **AFCESA's Plumbing and Natural Gas Distribution Systems Program** web page. The design criteria must comply with **AFJMAN 32-1070**, *Plumbing,* and the **International Association of Plumbing and Mechanical Officials (IAPMO)** guidelines.

3.5.4 Fire Protection and Life Safety

This section provides key fire and life safety information that applies to CONUS and overseas locations. For overseas locations, review host nation laws and the Status of Forces Agreements to ensure the most stringent fire and life safety protection requirements are meet.

The facility fire and life safety protection design must conform to **UFC 3-600-01**, **International Building Code (IBC)**, and **NFPA 101** standards. **AFCESA's Fire and Life Safety Engineering Program** web page provides additional information to integrate cost effective fire protection and life safety design features into the munitions facility design. Additional fire protection and life safety requirements can be found in **DoD 6055.9-STD**, **AFMAN 91-201**, **Air Force Occupational Safety and Health (AFOSH)**, **American Water Works Association (AWWA) Standard C502**, *Dry-Barrel Fire Hydrants*, **NFPA 14**, *Installation of Standpipes, Private Hydrants, and Hose Systems*, and **Occupational Safety and Health Administration (OSHA)** standards.

A comprehensive facility design plan must be prepared and approved by the base Fire Department to show all fire protection and life safety features and systems. The design plan should include the following information (as a minimum).

1. Planned occupancy of the facility.
2. Occupant load (covering full authorization).
3. Type of construction.
4. Facility mission requirements (e.g., what type of munitions are planned for the facility, how many aircraft in the hangar, etc.).
5. Location of fire-rated walls, doors, and dampers including enclosures for hazardous munitions operating locations. Travel distances for employees working in munitions facilities should be a maximum of 25 ft (7.6 m) from the exit point, but never more than 75 ft (22.8 m). Review criteria in **AFMAN 91-201**, local building codes, and **NFPA 101**.
6. Layout for automatic extinguisher systems (per **NFPA 13**, *Installation of Sprinkler Systems*) and locations of portable fire extinguishers (per **NFPA 10**, *Standard for Portable Fire Extinguishers).*
7. Specifications for the fire detection/internal alarm systems. Information for fire detection/internal alarm systems can be found at **AFCESA's Fire Detection and Alarm Systems** web page.
    a. The alarm and reporting system that conforms to the latest edition of **NFPA 72**, *National Fire Alarm Code*.
    b. A smoke/heat detection system, if appropriate.

c. Visible (e.g., strobes) and audible notification devices that may be easily detected throughout office and operating areas.

d. Carbon monoxide detection, as required.

8. Facility safety markings/signage plan that identifies exits, fire extinguisher locations, and other safety features as outlined in **AFOSH** and **OSHA** standards, **AFMAN 91-201**, and **UFC 3-120-01**.

3.5.5 Energy Conservation Measures

Energy conservation should be a consideration in designing a munitions facility project. Comply with **ETL 94-4**, *Energy Usage Criteria for Facilities in the Military Construction Program*, when applicable. To make the facility design functional from an energy conservation standpoint, the designer must consider and include, as required, the following energy conservation measures listed below.

1. Heating and cooling equipment should meet efficiencies defined in **Title 10 CFR 435**, *Energy*, Chapter II and **Energy Star** standards.

2. Limited-range thermostats should be used whenever possible. **Title 41 CFR**, *Federal Property Management Regulation*, and **DoD Energy Managers Handbook**, provide guidance and thermostat information.

3. Renewable energy technologies, such as ground source heat pumps, high temperature solar, and wind, should be used whenever feasible and cost effective.

4. Solar hot water systems should be considered. Water conservation fixtures, equipment and systems should be used whenever possible. Refer to **MIL HDBK 1165**, *Water Conservation*, for guidance.

The following additional factors are important when planning energy conservation measures for a munitions facility.

1. Orient the facility to take advantage of winter sun, prevailing winds, and natural landforms (e.g., protection from high winds). Minimize exposure in areas with hot summers.

2. Protect windows from direct summer sun by using overhangs, shades, blinds, solar film, tinted glass, solar screens, and shade from trees. Use weather stripping and caulking to reduce air infiltration.

3. Reduce temperature variation by utilizing energy efficient windows. This may include reduced glass area, window tinting, type of window construction, window placement (i.e., minimize

windows on southern exposures), and the use of dual-panel windows.

4. Consider the type and application of thermal insulation to provide the most long-term economical insulating value for the facility.

3.6 Telecommunications

Telecommunications distribution and cabling systems should be designed and installed in accordance with the latest Engineering Technical Letter (ETL) on pre-wiring, and should adhere to the requirements in **AFI 33-133**, *Joint Technical Architecture: Air Force (JTA-AF)* and recommendations in the *JTA-AF Fixed Based Technical Architecture, Vol. 6, Building 1040 Wiring Architecture Guide.* The design should be coordinated with the communications squadron.

3.7 Security Criteria

Security and force protection is an essential element of planning and designing Air Force facilities. This section describes munitions facility design measures that minimize the vulnerability of the facilities from terrorist attacks. This section includes information on antiterrorism/force protection (AT/FP) and physical security as well as communications and electronics security for munitions facility design.

Figure 3.17
Security Barriers Protecting Entrance to Munitions Storage Area - Cannon AFB, NM

3.7.1 Antiterrorism/Force Protection Criteria

AT/FP considerations must be integrated in the initial stages of the overall design for munitions facilities. Information regarding AT/FP design procedures can be found in **UFC 4-010-01**, *DoD Minimum Antiterrorism Standards for Buildings*, AFJMAN 32-1071 Volumes 1, 2, and 3, *Security Engineering Manuals* (FOUO), **UFC 4-021-01**, *Design and O&M: Mass Notification Systems* and **AFI 10-245**, *Air Force Antiterrorism (AT) Standards.* Units in operational theater commands (e.g., European Command (EUCOM), Pacific Command (PACOM), etc.), must comply with their respective command's and host nation AT/FP guidelines.

Figure 3.18
Security Lighting on Segregated Magazine - Langley AFB, VA

3.7.2 Physical Security

Physical security issues should be addressed during the planning and design of the site layout and building systems to enhance the physical security of the occupants, infrastructure, and munitions assets. The basic design criteria can be found in the **Installation Force Protection Guide** and **AFI 31-101**, *The Air Force Installation Security Program.* Specific design features for protecting munitions determined as sensitive arms, ammunition, and explosives (AA&E) (as defined by **DoD 5100.76-M**, *Physical Security of Sensitive Conventional Arms, Ammunition, and Explosives*) are identified in **AFH 32-1084**. Where applicable, provide

necessary infrastructure to support high-tech security devices such as remotely operated weapons systems.

3.7.2.1 Facility Site Design

Guidelines for site location planning address force protection issues such as orientation of buildings, integration of vehicle access, control points, physical barriers, placement of windows, landscaping, parking, and protection of utilities. Exterior utility systems and functional design concepts are also key design components for force protection.

3.7.2.2 Building Design

Facility design standards, such as architectural, structural, mechanical, interior design, and electrical systems are also important design elements for force protection. Building design can minimize the vulnerability to attack and loss of life through deterrence and detection, and strengthen the structure against a variety of terrorist tactics per **DoD 5100.76-M**, **Military Handbook 1013/1A**, *Military Handbook Design Guidelines for Physical Security of Fixed Land-Based Facilities*, and **AFI 31-101**.

3.7.3 Communications and Electronic Security

Communications and electronic security planning is a key element for the overall facility and site layout. Incorporate telecommunications and surveillance systems into the design that contribute significantly to security protection for munitions facilities. Key facilities such as Munitions Control and the entry control point to the munitions storage area can greatly benefit from use of intrinsically installed surveillance equipment. The advent of additional accountability, internal management, and munitions-specific research engines may place great demands on the telecommunications infrastructure. It is paramount that all aspects of electronic security and telecommunications systems infrastructure be designed to allow for future expansion.

3.7.3.1 Telecommunications Systems Design

Telecommunications planning is critical to system information assurance (security) issues such as operations, communications, computer, physical, and emission security. Guidelines for incorporating telecommunications systems into munitions facility design to optimize telecommunications security protection can be found in **AFI 33-104**, *Base-Level Planning and Implementation*, **ETL 02-12**, *Communication and Information Systems Criteria for Air Force Facilities*, and **AFMAN 33-105**, *Engineering and Installation Services*.

3.7.3.2 Electronic Intrusion Detection Equipment (IDE) and Systems (IDS) Design

IDE helps ensure minimum protection requirements by promptly detecting an attack on the area it is protecting. The IDE is part of an overarching IDS comprised of equipment and components used to detect and track intrusions, report and display alarms, remotely assess alarms,

Additional Security References

AFPAM 32-1010, *Land Use Planning*

U.S. Air Force Installation Force Protection Guide

DODI 2000.16, *DoD Antiterrorism Standards*

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

AFJMAN 32-1071 Volumes 1, 2, and 3, *Security Engineering Manuals* (FOUO)

UFC 4-021-01, *Design and O&M: Mass Notification Systems*

DoD 5100.76-M, *Physical Security of Sensitive Conventional Arms, Ammunition, and Explosives*

Figure 3.19
High Security Hasp on Storage Igloo - Luke AFB, AZ

and alert security forces to enhance the protection of resources and facilities. The guidelines for incorporating IDE and IDS into munitions facility designs can be found in **AFI 31-101.**