FC 4-420-07F
24 April 2018

FACILITIES CRITERIA (FC)

AIR FORCE NUCLEAR WEAPONS-CAPABLE MAINTENANCE AND STORAGE FACILITIES

FACILITIES CRITERIA (FC)

AIR FORCE
NUCLEAR WEAPONS-CAPABLE MAINTENANCE AND STORAGE FACILITIES

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

This FC supersedes ETL 11-7, *Nuclear Weapons-Capable Maintenance and Storage Facilities*, dated 1 September 2011.

FOREWORD

Facilities Criteria (FC) provide functional requirements (i.e., defined by users and operational needs of a particular facility type) for specific DoD Component(s), and are intended for use with unified technical requirements published in DoD Unified Facilities Criteria (UFC). FC are applicable only to the DoD Component(s) indicated in the title and do not represent unified DoD requirements. Differences in functional requirements between DoD Components may exist due to differences in policies and operational needs.

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 FC, the SOFA, the HNFA, and the BIA, as applicable.

Because FC are coordinated with unified DoD technical requirements, they form an element of the DoD UFC system applicable to specific facility types. The UFC system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and are applicable to the Military Departments, Defense Agencies, and DoD Field Activities. The UFC System also includes technical requirements and functional requirements for specific facility types, both published as UFC documents and FC documents.

FC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and the Air Force Civil Engineer Center (AFCEC) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content 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 site listed below.

FC 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/.

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

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FACILITIES CRITERIA (FC)
NEW SUMMARY SHEET

Document: FC 4-420-07F, *Air Force Nuclear Weapons-Capable Maintenance and Storage Facilities*

Superseding: ETL 11-7, *Nuclear Weapons-Capable Maintenance and Storage Facilities*

Description:

This document provides criteria specific to new and existing nuclear weapons-capable maintenance and storage facilities, including unique criteria related to design, construction, sustainment, restoration, and modernization.

Reasons for Document:

This document supersedes ETL 11-7 to provide facilities criteria for the use and guidance of those charged with the design, construction, renovation, and maintenance of nuclear weapons-capable maintenance and storage facilities. The performance goals of this document are to ensure that:

- Lightning strikes to the facility will not result in a side flash inside the facility that will compromise the surety of nuclear weapons
- Facility power systems, including all emergency power systems, are adequate to supply power to facility systems required to maintain the surety of nuclear weapons
- Facility structural supports for hoists, cranes, and lifting devices are adequately rated for the design loads
- Security meets the requirements of Department of Defense (DoD) S-5210.41/Air Force Manual (AFMAN) 31-108
- Nuclear surety deviations for existing facilities and essential facility systems are documented in accordance with AFI 91-101
- Blast containment and isolation systems mitigate contamination of facilities and weapons by limiting radiation transport mechanisms such as explosions, blasts, and fires
- Studies, including a fire hazard analysis (FHA), an electromagnetic radiation environment (EMRE) survey, and a facility characterization for the seven-foot rule (if implemented), are conducted to support the adequate design and operational issues in these areas, ensure the safety of weapons, and provide baseline documentation

- Updates to these studies, including for the FHA, EMRE, and facility characterization (if implemented), are conducted if any proposed facility change or modification involves, affects, or impacts systems covered by the existing studies, and the updated studies reflect the effect of the modification on study conclusions and recommendations

- Fire safety designs are implemented to ensure that:

  - Fire during any operational state will not prevent the facility plant from maintaining nuclear weapons in a safe, secure, and stable condition

  - Fire will not result in a radiological release that adversely affects the public, facility personnel, or the environment

  - Fire hazards to personnel are minimized by adding areas of refuge to restricted access/egress rooms

  - A fire will be limited such that facility damage, economic loss, and interruption of support to DoD missions are limited to an acceptable level, as defined by the Cognizant Office of Responsibility

- Provide criteria for new combined industrial and storage limited-access facilities

This document is intended to be used as a basis for the development of detailed design documents (including scope, basis of design, technical requirements, plans, drawings, specifications, cost estimates, request for proposals, and invitations for bids) used for the procurement of facilities, facility similar equipment, and other infrastructure systems. This document must be used as a reference document and requirement in the procurement of architectural and engineering (A&E) services and other consulting services to prepare detailed design documents, including those for design-build projects. It is not intended to be used in lieu of detailed design documents in the procurement of facility construction.

Impact:

Relative to ETL 11-7, this FC should have no impact on design cost, initial cost, energy savings, or life cycle costs.

Disclaimer: Use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the Air Force.

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CHAPTER 1 INTRODUCTION

1-1 PURPOSE AND SCOPE

1-1.1 General

This document provides criteria specific to new and existing nuclear weapons-capable maintenance and storage facilities, including unique criteria related to (but not limited to) facility sustainment, restoration, and modernization (FSRM), and military construction (MILCON), including design and construction. These criteria apply both to spaces where nuclear weapons may be located and to spaces and supporting systems required for nuclear weapons surety. These facilities are relatively few in number and are uniquely designed to protect the Air Force mission, ensure continuity of facility operations, limit property damage, and provide on-site personnel safety.

1-1.2 Basis of Design

This document is intended to be used as a basis for the development of detailed design documents (including scope, basis of design, technical requirements, plans, drawings, specifications, cost estimates, request for proposals, and invitations for bids) used for the procurement of facilities, facility similar equipment, and other infrastructure systems.

1-1.3 Procurement of Services

This document must be used as a requirement in the procurement of architectural and engineering (A&E) services and other consulting services to prepare detailed design documents, including those for design-build projects. It is not intended to be used in lieu of detailed design documents in the procurement of facility construction.

1-1.4 Performance Goals

The performance goals of this document are to ensure that:

- Lightning strikes to the facility will not result in a side flash inside the facility that will compromise the surety of nuclear weapons
- Facility power systems, including all emergency power systems, are adequate to supply power to facility systems required to maintain the surety of nuclear weapons
- Facility structural supports for hoists, cranes, and lifting devices are adequately rated for the design loads
- Security meets the requirements of DoD S-5210.41 / AFMAN 31-108
- Nuclear surety deviations for existing facilities and essential facility systems are documented in accordance with AFI 91-101

- Blast containment and isolation systems mitigate contamination of facilities and weapons by limiting radiation transport mechanisms such as explosions, blasts, and fires
- Studies, including an FHA, an EMRE survey, and a facility characterization for the seven-foot rule (if implemented), are conducted to support the adequate design and operational issues in these areas, ensure the safety of weapons, and provide baseline documentation
- Updates to these studies, including for the FHA, EMRE, and facility characterization (if implemented), are conducted if any proposed facility change or modification involves, affects, or impacts systems covered by the existing studies, and the updated studies reflect the effect of the modification on study conclusions and recommendations
- Fire safety designs are implemented to ensure that:
    - Fire during any operational state will not prevent the facility from maintaining weapons in a safe, secure, and stable condition
    - Fire will not result in a radiological release that adversely affects the public, facility personnel, or the environment
    - Fire itself will not cause a loss of life to those not intimately exposed to the fire origin, and injuries are minimized for those that are intimately exposed
    - Fire hazards to personnel are minimized by adding areas of refuge to restricted access/egress rooms
    - A fire will be limited such that facility damage, economic loss, and interruption of support to DoD missions are limited to an acceptable level, as defined by the Cognizant Office of Responsibility

1-2 APPLICABILITY

This document is applicable to Air Force installations with nuclear weapons-capable maintenance and storage facilities.

1-3 GENERAL BUILDING REQUIREMENTS

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

Topics and criteria not included in this FC are those adequately addressed in the engineering criteria for DoD buildings as found in published UFC documents.

Unique fire protection and life safety criteria have been developed for nuclear weapons-capable maintenance and storage facilities as included in this FC.

1-4 REFERENCES

Appendix A contains a list of references used in this document. The publication date of the code or standard is not included in this document. In general, the latest available issuance of the reference is used.

1-5 GLOSSARY

Appendix C contains acronyms, abbreviations, and terms.

1-6 CRITERIA

National consensus criteria are utilized for the facilities addressed in this document as appropriate; however, consensus criteria for some systems and components necessary to accomplish the Air Force mission are not available. This document contains special criteria as needed to meet mission requirements.

1-7 CONFLICTS WITH EXISTING CRITERIA

In case of conflict with any UFC, the criteria in this document will take precedence.

1-8 COGNIZANT OFFICE OF RESPONSIBILITY

The following organizations each serve in the role of Cognizant Office of Responsibility for the establishment of specific requirements in this document:

- Air Force Civil Engineer Center, Operations and Programs Support Division (AFCEC/CO): Serves as preparing activity for this document and serves as the Cognizant Office of Responsibility for civil engineering-related issues. AFCEC also serves as the Cognizant Office of Responsibility for personnel safety-related issues. Equivalencies and exemptions to the requirements of this document (see paragraph 1-9) are issued by AFCEC after receiving coordination from other applicable Cognizant Offices of Responsibility.
- Air Force Nuclear Weapons Center (AFNWC): Serves as a Cognizant Office of Responsibility with particular emphasis on the effects on nuclear surety from facility design issues and FHAs.
- Air Force Safety Center, Weapons Safety Division (HQ AFSEC/SEW): Serves as a Cognizant Office of Responsibility for both nuclear weapons surety and specific personnel safety-related issues as annotated in this document.

- Headquarters Air Force Security Forces, Nuclear Security Division (AF/A4SN): Serves as a Cognizant Office of Responsibility for security-related issues.

The following organization serves in the role for implementation of specific requirements of this document:

- Headquarters, Air Force Global Strike Command (HQ AFGSC): Provides guidance to maintain operational and readiness issues affecting nuclear surety.

1-9 EQUIVALENCIES AND EXEMPTIONS

1-9.1 Equivalencies

Equivalencies to established criteria of this document may be proposed and developed by a Cognizant Office of Responsibility if the alternate engineering design provides an equivalent level of protection to that intended by this document. Requests for approval must be submitted to AFCEC by the appropriate Cognizant Office of Responsibility and must include written justification, including items such as a hazard analysis, cost comparison, criteria used, and other pertinent data. Lack of funds will not be considered sufficient justification for non-compliance with established criteria. Approved equivalencies and alternatives apply only to the specific facility involved and do not constitute blanket approval for similar cases. For issues involving physical security, refer to DoD S-5210.41-M / AFMAN 31-108. For issues involving weapons safety, refer to AFI 91-101.

NOTE: Nuclear surety deviations must also comply with paragraph 1-10 of this document.

NOTE: Certain paragraphs in this document include text similar to "…as approved by the Cognizant Office of Responsibility." That text is intended to indicate that the Cognizant Office of Responsibility is authorized to select a design option or modify that specific criteria without the requirement to submit a request for equivalency to AFCEC.

1-9.2 Exemptions

Exemptions to established criteria of this document may be proposed and developed by a Cognizant Office of Responsibility. Requests for approval must be submitted to AFCEC by the appropriate Cognizant Office of Responsibility and must include written justification. An exemption must demonstrate that the criteria cannot be technically executed or execution of the criteria will increase a hazard or create a new hazard and no technical alternatives exist. Request for exemption must include written justification, including items such as a hazards analysis, cost comparison, alternatives considered, and other pertinent data. Lack of funds or cost savings will not be considered sufficient justification for non-compliance with established criteria. Exemptions apply only to the

specific facility or project involved and do not constitute blanket approval for similar cases. Exemptions must follow the process outlined in MIL-STD-3007F. For issues involving physical security, refer to DoD S-5210.41-M / AFMAN 31-108. For issues involving weapons safety, refer to AFI 91-101.

NOTE: Nuclear surety deviations must also comply with paragraph 1-10 of this document.

NOTE: Certain paragraphs in this document include text similar to "…as approved by the Cognizant Office of Responsibility." That text is intended to indicate that the Cognizant Office of Responsibility is authorized to select a design option or modify that specific criteria without the requirement to submit a request for exemption to AFCEC.

1-10 NUCLEAR SURETY DEVIATIONS AND WAIVERS

In addition to the requirements of this document, all modifications/alterations to an existing nuclear-certified facility or an essential facility system as listed within this document must be documented using the deviation process outlined in AFI 91-101, Chapter 3. That document establishes procedures for MAJCOMs to request deviations to nuclear enterprise-related policy and guidance. This documentation requirement for deviations also includes security deviations.

For the purposes of facility nuclear certification, specific requirements herein are identified in a separate document known as the Certification Requirements Plan (CRP), in accordance with AFI 63-125. Those specific requirements included in the CRP depend on the individual facility's design and function.

If a proposed design modification/alteration conflicts with required nuclear surety-related design criteria, MAJCOMs must use the process in AFI 91-101 to obtain approval. Deviation requests are not required to be submitted for an existing operational system or component solely due to enhanced safety criteria that was implemented after the system or component was originally operationally certified. However, when subsequently modifying/altering an existing system or component, that enhanced safety criteria becomes applicable and deviation requests are required.

Waivers must be adjudicated using the process outlined in AFI 33-360.

1-11 RETROACTIVITY

1-11.1 Level of Protection

The provisions of this document are considered necessary to provide an acceptable level of protection against loss of life and property and to minimize impact to the facility mission. This document applies to new and existing facilities.

1-11.2 Application

Unless specifically noted in this document, the provisions of this document must not be applied retroactively unless determined by the FHA or other approved documented analyses that the existing situation involves a distinct hazard to life, mission, property, or the environment.

1-11.3 Alterations and Limitations

This document also applies when a facility is altered, renovated, or modernized (see specific definitions of these terms in UFC 3-600-01). It is recognized that certain requirements within this document are not possible or practical in existing structures; therefore, a documented evaluation will be provided to the Cognizant Office of Responsibility and, if applicable, to the system program manager (SPM) in accordance with AFI 63-125 as a technical justification for the acceptability of the proposed configuration. Such justifications must provide a sound technical basis for nonconformance that may include a benefit-to-cost analysis.

CHAPTER 2 LIGHTNING PROTECTION SYSTEMS AND SIDE FLASH PROTECTION

NOTE: Cognizant Offices of Responsibility for this chapter are AFCEC and AFSEC.

2-1 SCOPE

This chapter provides the criteria necessary for adequate protection of weapons from the energy of lightning strikes to new and existing nuclear weapons-capable facilities.

2-2 LIGHTNING PROTECTION SYSTEMS

2-2.1 Requirements

Lightning protection systems (LPS) for nuclear weapons-capable maintenance and storage facilities must meet the requirements of:

- Department of Defense Directive (DoDD) 6055.9E
- DoD 6055-09-M

Air Force LPSs must also comply with the following:

2-2.1.1 All facilities, except for underground facilities, will be provided with an LPS in accordance with National Fire Protection Association (NFPA) 780, AFI 32-1065, AFMAN 91-201, AFMAN 91-118, and UFC 3-520-01.

2-2.1.2 Underground facilities do not require an LPS. A counterpoise grounding system will be provided that meets the requirements of NFPA 70, AFI 32-1065, UFC 3-520-01, and AFMAN 91-201.

2-2.2 Design Approaches

LPSs will be designed to traditional LPS parameters. These systems must be designed to meet the requirements of AFI 32-1065, AFMAN 91-201, and NFPA 780. Traditional LPS design consists of the use of strike termination means, low impedance paths to ground, and earth electrode systems, coupled with bonding of all conductive penetrations into the protected facility, surge suppression, and side flash protection.

2-2.3 Special Documentation of LPS During Construction

During construction, establish clear, comprehensive documentation (including photographs) of the as-built installation of the LPS counterpoise, connection to ground rods, and interconnection to other systems. The photos must be taken while the counterpoise and connections are still exposed and visible prior to the placement of backfill or other coverage material. The installing contractor will include this documentation with the project as-built submittals with written certification of its accuracy. Provide Geographic Information System (GIS) data coordinates of photograph/connection locations and of the permanent reference points to enable base personnel to subsequently locate and uncover any connection point in the system. The

installing contractor will include this geospatial data with the project as-built submittals with written certification of its accuracy.

2-3 NUCLEAR WEAPONS SIDE FLASH PROTECTION REQUIREMENTS

2-3.1 Requirements

Side flash protection must be addressed as required in AFMAN 91-118 and AFMAN 91-201.

2-3.2 Lightning Side Flash Protection Policy for Nuclear Weapons Configurations

Apply standards in accordance with AFMAN 91-201. This is commonly referred to as the “seven-foot rule.”

2-3.3 Side Flash Protection Characterization

When the facility is determined under AFMAN 91-118 and AFMAN 91-201 as being subject to characterization under the seven-foot rule reduction, each bond will be given a unique identification number and be permanently tagged to display this number and the purpose of the bond, such as “FARADAY SHIELD BOND.” Document the location, configuration, and identity of each bond in a permanently maintained drawing file and with a geospatial record. Documentation must also include photos that show the connection method of the facility rebar forming the Faraday shield and the bonding of the penetrations.

2-3.3.1 Metallic Penetrations

Bonds will have a maximum resistance of 1 ohm across the connection to the Faraday shield to ground.

2-3.3.2 Alternative Measures for Communications and Data Circuits

When it is not practical to install suppression capable of interrupting the energy levels of the established 1 percentile lightning strike on communications and data circuits, alternatives must be in place to minimize the possibility of the lightning energy entering the facility through these conductors. Provide an evaluation and analysis of these alternatives to the Cognizant Offices of Responsibility for review and approval prior to implementation. Factors to consider in determining the practicality of installing the required surge suppression or the acceptability of alternatives will include at least:

- The quantity and associated costs of installing the required surge suppressors for the number of conductors involved
- The volume of space necessary to install the required suppression units
- The exposure of the portions of the system that are external to the Faraday shield to lightning strikes

- The impact on system performance if installing the required suppression units
- The protection provided using standard commercial surge suppressors manufactured for the application

2-3.3.3 Design of New Facilities

Design new facilities to successfully complete the characterization process prior to activating the facility.

2-3.3.4 Testing of New Facilities

Complete the characterization evaluation prior to activating the facility.

2-3.3.5 Testing of Existing Facilities

Complete the characterization evaluation prior to reducing the required separation distances less than those required by the seven-foot rule.

2-3.3.6 Documentation Retention

The facility will maintain documentation of the characterization process, including at least these items:

- Cognizant Offices of Responsibility requirements
- Testing methodology
- Transfer impedance evaluation results
- Bonding methodology
- Faraday shield bonding records
- Bonding length calculations
- Suppression alternatives and mitigation methods

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CHAPTER 3 ELECTRICAL POWER AND LIGHTING SYSTEMS

NOTE: Cognizant Office of Responsibility for this chapter is AFCEC.

3-1 SCOPE

This chapter provides the criteria for electrical power and lighting systems necessary to protect weapons from electrical energy and provide emergency power and lighting to maintain essential operations without impacting mission requirements.

3-2 ELECTRICAL SYSTEMS

NOTE: Cognizant Office of Responsibility for this paragraph is AFCEC.

3-2.1 Design Criteria

Electrical systems for nuclear weapons-capable maintenance and storage facilities must be designed to meet the requirements of UFC 3-501-01, UFC 3-520-01, UFC 3-520-05, and UFC 3-550-01. Electrical systems will comply with NFPA 70 and Institute of Electrical and Electronics Engineers (IEEE) C2, *National Electrical Safety Code* (NESC), except as modified by UFC 3-501-01, UFC 3-520-01, or UFC 3-550-01. Electrical systems must comply with AFI 32-1062, AFI 32-1065, and AFMAN 91-201.

Facilities will be provided with an emergency power system to supply electrical power to all facility subsystems necessary to maintain the safety and security of nuclear weapons in accordance with AFI 32-1062.

3-2.2 Special Documentation of Grounding System

During construction, establish clear, comprehensive documentation (including photographs) of the as-built installation of the facility's grounding electrode system, connection to ground rods, and interconnection to other systems. The photos must be taken while the grounding electrode system and connections are still exposed and visible, prior to the placement of backfill or other coverage material. Include geospatial data from permanent reference points to enable base personnel to subsequently locate and uncover any connection point in the system. The installing contractor will include this documentation with the project as-built submittals with written certification of its accuracy.

3-2.3 Transformers

3-2.3.1 Indoors

Dry-type or liquid-filled transformers using FR3 dielectric fluid will be used for indoor applications. Transformers with hydrocarbon-based insulating oils will not be used indoors. Polychlorinated biphenyl (PCB) -filled transformers will not be used. The installation will comply with NFPA 70 requirements for transformers located inside buildings.

3-2.3.2 Separation Distances Outdoors

Outdoor transformers must meet the minimum separation distances from structures as specified in AFMAN 91-201 and UFC 3-600-01.

3-2.3.3 Cold Weather Conditions

Outdoor transformers, other than dry-type transformers, must contain insulating oils suitable for the cold weather conditions of the geographic location of the nuclear weapons-capable maintenance and storage area.

NOTE: Some dielectric fluids used as an alternative to hydrocarbon-based oils have significant changes in their dielectric properties when exposed to below-freezing conditions. Although these fluids may function appropriately in a continuously energized transformer that keeps the fluids warm, the transformer must always remain energized. It may not be possible to safely reenergize these transformers from an extended shutdown period in cold environments.

3-2.3.4 Testing

3-2.3.4.1 Transformers containing insulating mineral oils will be tested at least every five years to the specifications of the American Society for Testing and Materials (ASTM).

3-2.3.4.2 Testing frequency will be increased to at least annually for any transformer showing indication of abnormal mineral oil conditions or impending transformer breakdown.

3-2.3.4.3 Results of the testing will be evaluated to detect impending transformer breakdown and permit corrective maintenance before a transformer failure causes an unplanned power outage.

3-2.3.4.4 Testing must include at least the following:

- Dissolved gas-in-oil analysis (IEEE C57.104 and ASTM D3612)
- Oil testing, including:
  - Dielectric breakdown strength (ASTM D877 and ASTM D1816)
  - Neutralization (ASTM D974)
  - Interfacial tension (ASTM D971)
  - Color (ASTM D1524)
  - Moisture content (ASTM D1533)
  - Specific gravity (ASTM D1298)
  - Transparency and opacity (ASTM D1524)
  - Power factor (ASTM D924)

3-2.3.5 Spare Transformers

If the FHA report identifies critical transformers that, if lost, could have a severe impact to the facility mission, and if these transformers have a long replacement time (e.g., longer than 30 days), feasibility of procurement of a spare transformer must be evaluated by the installation commander and the results of the evaluation provided to HQ AFGSC.

3-2.4 Cabling

Cabling within nuclear weapons-capable maintenance and storage facilities must meet the specifications in UFC 3-520-01. The specific areas that must exceed the criteria within UFC 3-520-01 are addressed in paragraphs 3-2.4.1 through 3-2.4.3.

3-2.4.1 Combustible Cable Insulation and Jacketing Material

Combustible cable insulation and jacketing material will meet the fire and flame test requirements of IEEE 383. Meeting the requirements of IEEE 383 will not eliminate the need for other fire protection features as specified in this document.

3-2.4.2 Fiber Optic Cable Insulation and Jacketing Material

Fiber optic cable insulation and jacketing material will meet the fire and flame test requirements of IEEE 383.

3-2.4.3 Wire Management Systems

All wiring, including power, signal, communication, and control, will be installed in metallic conduit, except that metallic conduit is not required for those portions of underground conduit more than 50 feet (15.3 meters) from the facility (see AFMAN 91-201). Wireways or cable trays will not be used without approval of the Cognizant Office of Responsibility. Wireways and cable trays will not be used to run cables through the boundary of a blast containment zone.

3-2.4.3.1 Wireways

If the use of wireways is approved by the Cognizant Office of Responsibility, wireways will be made of noncombustible materials.

3-2.4.3.2 Cable Trays

If the use of cable trays is approved by the Cognizant Office of Responsibility, only metal will be used for cable trays (e.g., fiberglass-reinforced plastics are not permitted).

If the use of cable trays is approved by the Cognizant Office of Responsibility, cable tray fire breaks must be installed every 20 feet (6.1 meters) for vertical cable trays that rise over 30 feet (9.1 meters) unless they are protected with a fire-resistive coating. Access to cable shafts must be provided every 40 feet (12.2 meters), with the topmost

access within 20 feet (6.1 meters) of the cable shaft ceiling. Automatic sprinkler protection and smoke detection must be provided at the ceiling of the vertical shaft.

If the use of cable trays is approved by the Cognizant Office of Responsibility, horizontal cable trays must be provided with cable tray fire breaks every 50 feet (15.2 meters) unless the cable trays are protected with a fire-resistive coating.

3-2.4.3.3 Conduits

Conduits with an inside diameter larger than the trade size of 4 inches (standard metric size 103 millimeters) that pass through a fire barrier wall must be provided with an internal fire seal that has a fire-resistive rating equivalent to that of the fire barrier, and the internal fire seal will be permitted to be installed on either side of the barrier but in a location that is as close to the barrier as possible. Blast walls will also be provided with an explosion-proof conduit seal meeting the requirements of NFPA 70 for a Class I, Division 1 boundary.

Conduits with an inside diameter equal to or less than the trade size of 4 inches (standard metric size 103 millimeters) that pass through a fire barrier wall that is not also a blast wall will be provided with a fire-rated internal seal unless the conduit extends greater than 5 feet (1.5 meters) on each side of the fire barrier. In this case, the conduit opening will be provided with noncombustible material to prevent the passage of smoke and hot gases. The fill depth of the material packed to a depth of 2 inches (51 millimeters) will constitute an acceptable smoke and hot gas seal in this application.

Conduits with an inside diameter equal to or less than the trade size of 4 inches (standard metric size 103 millimeters) that pass through a fire barrier wall that is also a blast wall must be provided with an explosion-proof conduit seal meeting the requirements of NFPA 70 for a Class I, Division 1 boundary.

3-2.5 Battery Rooms

Battery rooms will comply with UFC 3-520-05. Loss of ventilation in a battery room will cause an alarm to be received at a constantly attended location (e.g., in the security control room or munitions squadron control). Exhaust air from the battery room is not required to be discharged directly to the outside for battery rooms located in underground (see Chapter 14) or restricted access/egress (see Chapter 17) areas of the facility.

3-2.6 Electrical System Analyses

Current electrical coordination, short-circuit, and load flow analyses for the facility will be maintained and kept with other facility records. These analyses will be used to ensure that proposed system modifications will not adversely affect system reliability.

3-2.7 Priority and Normal Electrical Power Loads

3-2.7.1 Priority Loads

Priority loads are designated as electrical system loads whose failure could result in loss of human life or serious injuries, or result in serious mission or security issues. Priority loads will be served by a permanent emergency engine generator power system. These loads include, but are not limited to:

- Security systems
- Entry control systems
- Maintenance area lighting and power
- Storage area lighting
- Shelter-in-place (refuge area) lighting and power
- Egress lighting
- Life safety systems
- Mechanical systems associated with a blast containment management system (BCMS)
- Fire alarm and reporting systems

3-2.7.2 Normal Loads

Normal loads are any electrical system loads not classified as a priority load.

3-2.8 Hardening of Electrical Power Systems

NOTE: Cognizant Offices of Responsibility for this paragraph are AFCEC, AF/A4S, and AFSEC.

Electrical power systems located within and serving the controlled areas of nuclear weapons-capable maintenance and storage facilities will be required to be hardened against unauthorized access and intentional acts that may result in damage to the systems. Hardening must incorporate one or more of these features: location within secured facility boundaries, active surveillance, alarms, physical barriers, access controls, shock- or vibration-resistant equipment mounts, or other methods that will prevent unauthorized access and damage to the supply, distribution, or controls of the normal and emergency power systems.

3-2.9 Emergency Power Systems

Emergency power systems must be capable of supporting all priority loads (see paragraph 3-2.7). Emergency power system types include, at a minimum, a real property installed equipment (RPIE) permanent engine-driven electric generator. In

addition, other types of electrical power systems may be approved by the Cognizant Office of Responsibility, such as uninterruptable power supplies (UPS) that use batteries as an interim source of emergency power. The capacity of a new or modified emergency power system must be approved by AFCEC at the 65 percent design point per AFI 32-1062.

3-2.9.1 Fuel Systems for Emergency Engine Generator Power Systems

Fuel systems for emergency engine generator power systems, including on-premises supply, will be afforded the same level of hardness required for the emergency engine generator power system itself. Furthermore, the on-premises supply will be sufficient to enable the emergency power systems to support all priority loads for at least 72 hours.

3-2.9.2 Automatic Transfer Switch (ATS)

ATSs connected to normal power and emergency power supplies must utilize a two-source-design, bypass-isolation transfer switch configuration. The design must allow the transfer switch to be isolated for inspection, calibration, and maintenance without requiring electrical system shutdown. The design must allow any single circuit breaker to be isolated for inspection, calibration, and maintenance of equipment without requiring electrical system shutdown. Circuit breaker-type bypass isolation transfer switches must be utilized when electrical coordination is required.

3-2.9.3 Manual Transfer Switch

Manual transfer switches connected to normal power and emergency power supplies must be provided with isolation and bypass breakers to allow the manual transfer switch or any single breaker to be isolated for inspection, calibration, and maintenance without requiring electrical system shutdown.

3-2.9.4 Tertiary Connection Point

Facilities will be provided with a tertiary connection point for a mobile engine generator system independent of the permanently installed facility engine generator set. This connection point must be capable of sustaining all priority loads.

3-2.10 Surge Protection

3-2.10.1 Existing Facilities

For existing facilities, unless approved in the FHA, provide surge protection sized to reduce transient voltages, including those produced by lightning, to a harmless level on all entering or exiting metallic power, intrusion detection, communication antennas, and instrumentation lines in accordance with UFC 3-520-01. Install the surge protection as near as practical to where the conductor enters the interior of the facility.

3-2.10.2 New Facilities

For all new facilities, surge protection must meet the requirements in Chapter 2 in addition to the requirements in UFC 3-520-01, AFI 32-1065, and AFMAN 91-201.

3-3 TEMPORARY ELECTRICAL WIRING

Comply with NFPA 70 and the requirements listed in paragraph 10-5.

3-4 LIGHTING

NOTE: Cognizant Office of Responsibility for this paragraph is AFCEC.

3-4.1 Normal Lighting

Normal lighting will be provided as required by UFC 3-530-01.

3-4.2 Photoluminescent Egress Path Marking

Non-powered luminescent path markings must be provided for egress access routes in all areas that may contain nuclear weapons and leading to areas of refuge. Non-powered luminescent path markings will meet the performance requirements listed in NFPA 101. The installation of luminescent path markings will consider the amount of ambient lighting available throughout the day to ensure the level is sufficient to keep the marking charged in accordance with the manufacturer's requirements.

3-4.3 Photoluminescent Egress Door Marking

Egress doors in areas that may contain nuclear weapons and doors into areas of refuge must be marked with non-powered photoluminescent signs that are uniquely marked to avoid confusion with normal egress doors. These signs will be installed in accordance with the manufacturer's requirements. Particular attention must be given to the requirement for the level of background ambient lighting to ensure the signs remain charged. If this criterion cannot be met then electrically powered exit marking must be used (e.g., light-emitting diode [LED] signs).

3-4.4 Emergency Lighting

Emergency lighting will be provided for the egress access routes, security staging and operating locations, and firefighting staging and operating locations in accordance with NFPA 101. Emergency lighting for security staging and operating locations and firefighting staging and operating locations may be required to be at a higher level to meet operational requirements. The required illumination levels will be documented in the FHA. Self-testing emergency lighting fixtures will be installed in all areas except when limited by EMRE considerations. In those EMRE-limited locations, normal power to the emergency lighting will be provided by a dedicated electrical circuit to allow periodic testing without de-energizing other electrical equipment.

3-4.4.1 Testing

Permanently mounted emergency lighting units using batteries will be tested and inspected to verify proper operation based on the requirements of NFPA 101.

3-5 SECURITY LIGHTING

AF/A4SN serves as the Cognizant Office of Responsibility for this section.

Security lighting will be in accordance with DoD S-5210.41-M / AFMAN 31-108. The Cognizant Office of Responsibility will specify if the facility will be classified as a lighted site or unlighted site.

CHAPTER 4 STRUCTURAL SUPPORT FOR HOISTS, CRANES, AND LIFTING DEVICES

NOTE: Cognizant Offices of Responsibility for this chapter are AFCEC and AFSEC.

4-1 SCOPE

This chapter provides criteria to ensure facility structural elements are capable of supporting the safety design requirements for those hoists, cranes, and lifting devices that are subject to AFMAN 91-118. In general, this chapter provides structural criteria that exceeds the minimum requirements of UFC 1-200-01.

4-2 STRUCTURAL REQUIREMENTS

Ensure items such as load frames, hoist trolleys, test and storage stands, and handling units provide at least the design load capability. See AFI 91-203 for additional requirements. The design load is the rated load multiplied by a factor as required in AFMAN 91-118. This design load is considered the minimum load for design of the facility structural elements required to support the hoist, crane, or similar device.

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CHAPTER 5 SECURITY SYSTEMS

NOTE: Cognizant Office of Responsibility for this chapter is AF/A4S.

5-1 SCOPE

This chapter provides criteria for the physical security necessary to meet the applicable DoD nuclear weapon system safety standards and considers systems design, access analysis, and other features to ensure the applicable standards have been met.

5-2 DESIGN CRITERIA

5-2.1 Minimum Physical Security Design

At a minimum, physical security design will be in accordance with DoD S-5210.41 / AFMAN 31-108.

5-2.2 Systems Engineering Perspective

Physical security system designs will be approached from a systems engineering perspective to identify potential impacts to the safety of nuclear weapons systems and to ensure compatibility (including an EMRE survey) with nuclear weapon systems.

5-2.3 Security Integration

Facility design must account for electronic security system (ESS) and Remote Targeting Engagement System (RTES) infrastructure requirements (e.g., wall penetrations, power/communications system requirements) to ensure construction and facility certification. See Chapter 7 for additional requirements.

5-3 SECURITY CONTROL ROOM COMPLEX

5-3.1 When Required

Provide a security control room complex when required by other chapters in this document.

5-3.2 Physical Separation

The security control room complex must be protected against exposure fire damage and will be separated from other fire areas of the plant by floors, walls, doors, and ceilings having a minimum fire resistance rating of 3 hours.

5-3.3 Windows

Windows in fire barriers for the security control room complex will be provided with a listed or approved fire shutter or automatic wall curtain having a minimum fire resistance rating of 3 hours.

5-3.4 Peripheral Rooms

Peripheral rooms supporting the security control room complex but within the same fire area must have an automatic water-based suppression system, and will be separated from the control room by noncombustible construction with a minimum fire resistance rating of 1 hour.

5-3.5 Ventilation System Openings

Ventilation system openings between the control room and the peripheral rooms must have automatic smoke or combination fire and smoke dampers installed that will close on operation of the fire detection or fire suppression systems.

5-3.6 Manual Firefighting

Manual firefighting capability will be provided for:

- Fires originating within a cabinet, console, or connecting cables
- Exposure fires involving combustible materials in the general surrounding room areas

A fire hose station will be installed immediately outside of the security control room (see Chapter 11).

5-3.7 Portable Fire Extinguishers

Portable Class A and Class C fire extinguishers will be located in the security control room. Clean agent or carbon dioxide (CO_2) portable fire extinguishers will be used for electrical hazards.

5-3.8 Smoke Detection

Smoke detectors will be provided in the control room complex, including the interior of electrical cabinets and consoles (see Chapter 11).

5-3.9 Breathing Apparatus

Provision for breathing air (e.g., dedicated ventilation system or breathing apparatus) for the security control room operators must be readily available, with a minimum 72-hour capacity.

5-3.10 Smoke Venting

Manually operated smoke venting of the security control room will be available to the control room personnel (see Chapter 11).

5-3.11 Electrical Cables

All electrical cables that enter the control room will terminate in the control room. No cabling will be routed through the control room from one area to another. Fully enclosed electrical raceways located in such under-floor and ceiling spaces, if over 1 cubic foot (0.03 cubic meter), must have automatic fire suppression internally. Area automatic fire suppression must be provided for under-floor and ceiling spaces if used for cable runs unless all cable is located in 4-inch (standard metric size 103 millimeter) or smaller steel conduit, or unless cables are fully enclosed within raceways internally protected by automatic fire suppression. See Chapter 3 regarding the use of wireways or raceways and for requirements for conduit seals.

5-3.12 Air Handling

Air handling functions will be ducted separately from cable runs. If cables are routed in under-floor or ceiling spaces, these spaces will not be used as air plenums for ventilation of the control room.

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CHAPTER 6 FACILITY AUTOMATA AND SOFTWARE

NOTE: Cognizant Office of Responsibility for this chapter is AFSEC.

6-1 SCOPE

This chapter provides criteria for facility automata and software that is unique and developed or written specifically to control essential facility systems (EFS).

6-2 DEFINITION OF EFS

EFS are defined as those facility systems that directly impact the safe maintenance, handling, and storage of nuclear weapons (see AFMAN 91-118).

6-3 AUTOMATA AND SOFTWARE REQUIREMENTS

6-3.1 Software

All software (including facility security system software) that is unique and developed or written specifically to control EFS must meet the requirements of AFMAN 91-119.

6-3.2 Exempted Embedded Software and Firmware

Embedded software and firmware that is installed by the equipment manufacturer, is commercially available, is incapable of being modified without the manufacturer's authorization, and is common to all identical equipment without modification to the program itself does not fall under the requirements of AFMAN 91-119 and does not require separate nuclear safety certification for the software and firmware.

6-4 EFS DESIGN CONSIDERATIONS

6-4.1 Protection of EFS Interfaces

Control of EFS is nearly always accomplished by embedded software and firmware, or, in some instances, by unique software written specifically for that purpose. Typically, EFS are interconnected and provide integrated systems operations. Interfaces between EFS must be designed to ensure the nuclear surety environment is maintained. Design considerations may include, but are not limited to:

- Placing control panels and interface connections and equipment in locked, secure cabinets and placing the cabinets in a secure environment
- Ensuring the interconnections and equipment are passive
- Minimizing exposure of interconnection wiring to unauthorized access (i.e., enclosing in conduit)

6-4.2 Protection from Power Fluctuations

All software and computer system hardware for EFS must be robust and insensitive to normal power fluctuations, spikes, and dips. Hardware will be provided with supplemental power such as battery backup or UPS, or be connected to a power supply that has reserve capabilities.

CHAPTER 7 CONTAINMENT AND ISOLATION FEATURES

NOTE: Cognizant Office of Responsibility for this chapter is AFSEC.

7-1 SCOPE

This chapter provides criteria and requirements for hazard classification and containment and isolation features for the purpose of limiting the spread of contamination and consequential damage to weapons, areas within the facility, and the environment.

NOTE: Fire protection (e.g., automatic sprinklers) and fire detection (e.g., fire alarm systems) are intended to be configured to coincide with required containment zones and with corresponding heating, ventilation, and air conditioning (HVAC) zones. This will reduce penetrations through the barrier walls by the fire protection equipment and also improve the survivability of the systems (refer to Chapters 5 and 11). Life safety issues related to containment are discussed in subsequent chapters of this document.

7-2 REFERENCES

Guidance for hazard classification and containment and isolation system features, including blast, fire, and contamination, is provided in the following documents:

- AFMAN 91-201
- AFMAN 91-118
- DoD 6055.09
- DOE O 440.1B
- UFC 3-340-02
- DDESB Memorandum “Minimum Requirements to Validate Explosive Safety Protective Construction,” dated 21 October 2008
- DDESB Technical Paper 16, “Methodologies for Calculating Primary Fragment Characteristics,” Revision 4, dated 2 August 2012

7-3 DESIGN FEATURES

Facility containment and isolation design features shall include, as a minimum:

- The ability to contain and/or isolate the maximum credible event (MCE), also referred to as the design basis accident (government-furnished information). If the MCE does not involve a blast scenario, measures are still required to prevent spread of contamination

- The ability to mitigate contamination of facilities, weapons, and the environment by limiting radiation transport mechanisms such as explosions, blasts, and fires
- Incorporation of containment and/or isolation zones for the purpose of limiting the spread of contamination and consequential damage to the facility, stored critical assets, or to the environment
- Blast-resistant barriers separating blast zones (if required) that are capable of withstanding explosions commensurate with the maximum credible event of the zone as described in paragraph 7.5
- Compatibility between factors such as site requirements, blast zones and/or containment zones, overpressures, isolation requirements, HVAC, penetrations, doors, and drainage requirements
- Appropriate filtering capable of removing radioactive airborne materials from exhaust air (not including tritium gas).
- The capability for venting or isolating the facility with respect to environmental air
- The capability for monitoring the interior of the facility for specific types of radiation
- Integration with other systems, such as HVAC, fire alarm, and security, to achieve a coordinated and managed environment.
- The ability to accomplish remote control of containment/isolation systems by specific authorized personnel in the facility control center

7-4 CONTAINMENT SYSTEM ELEMENTS

7-4.1 Containment Zones

Containment zones shall be arranged to coincide with HVAC zones and fire zones (as separated by fire barrier walls) to the maximum extent possible (also see Chapter 11).

7-4.2 Radiological Filter Systems

A radiological filter system will be provided to protect against contaminated air being released to the outside environment without suitable filtering. The radiological filter system may be designed to serve one or more containment zones.

7-4.3 Plumbing Valves

7-4.3.1 Remotely air-operated, quick-acting isolation ball valves will be added in the construction to aid in contaminant control in air systems. Remotely air-operated quick-acting isolation ball valves shall be placed on domestic water lines, sewer lines,

fuel lines, and other plumbing lines to prevent contaminating particles from reaching the water source. These valves shall be configured to fail in the closed position.

7-4.3.2 These valves shall be integrated with the radiation monitoring system**.**

7-5 BLAST CONTAINMENT/ISOLATION SYSTEM ELEMENTS

When the MCE includes a potential blast, the elements of this section apply.

NOTE: Not all facilities require the use of blast containment and isolation features. Contact the Cognizant Offices of Responsibility for the applicability of this chapter to a new or existing facility.

7-5.1 Blast Containment and Isolation System Elements

Blast containment and isolation system elements include, but are not limited to, blast containment zones, blast-resistant barriers (i.e., walls, floors, and ceilings), blast doors, blast valves, HVAC systems, and plumbing systems.

7-5.2 Blast Containment Zones

Blast containment zones shall be arranged to coincide with HVAC zones and fire zones (as separated by fire barrier walls) to the maximum extent possible (also see Chapter 11). Blast containment zones shall be constructed to be as gastight as possible. The construction of the area shall meet the gastight criteria, e.g., reinforced concrete, steel blast doors, pipes, valves, and seals. Each area shall be designed such that both during and after an explosive event the gastight capability of the area will not be less than that required of the seals of the blast doors (see paragraph 7-5.4)

7-5.3 Blast-Resistant Barriers

Blast-resistant barriers, such as walls, floors, and ceilings, will be designed to resist blast loads in any area subject to accidental explosion. Concrete cracking shall be limited to discontinuous hairline-type cracks such that the migration of contaminants through these cracks will be severely limited. Spalling on the protected side of the wall shall be limited, and the integrity of the wall shall be maintained considering the combined fragment impact and blast pressure commensurate with the maximum credible event. Penetrations of the blast-resistant barriers shall be limited to only those services necessary to serve the blast zone encompassed by the blast-resistant barriers. The penetrations will be protected by blast valves, explosion-proof seals, or other such means necessary to maintain the integrity of the barrier. Where sprinkler piping penetrates a blast barrier, other means of protection shall be considered to ensure that the system maintains NFPA code compliance, such as zoning the sprinkler systems such that a single sprinkler system would service a single blast zone.

NOTE: When necessary to prevent subsequent criticality events following a blast the sprinkler system inside the blast zone may need to be isolated simultaneously with the operation of the blast valves.

7-5.4 Blast Doors

7-5.4.1 Configuration

The preferred configuration is a single-leaf swing blast door; however, other configurations are acceptable (e.g., vertical sliding blast doors) if the blast doors will provide the required protection and blast containment.

7-5.4.2 Construction

The doors shall be constructed of material that will provide the required blast resistance characteristics. When required, the door shall also be constructed of material that will provide the required delay characteristics. There shall be specific test data or modeling, as approved by the Cognizant Office of Responsibility, which demonstrates the capability of the material selected to meet the required blast resistance and, if required, also delay characteristics.

7-5.4.3 Blast Resistance

The door material shall be of sufficient thickness and strength to withstand the blast pressures imposed on it. At a minimum, it shall resist the blast pressure associated with the maximum credible event of the area being protected.

7-5.4.4 Door Operators

The door operating system shall include a stored energy system that shall be capable of operating through not less than two complete cycles without relying on external power. Furthermore, upon loss of power, the door operating system shall automatically cycle the doors to a failsafe position that meets the applicable security and safety requirements.

7-5.4.5 Door Control

NOTE: Cognizant Offices of Responsibility for this paragraph are AFSEC and AF/A4S.

Controls for the door operators shall be compatible with the physical security requirements mandated by the applicable criteria of DoD S-5210.41-M / AFMAN 31-108. A manual means of opening the door from either side shall be provided.

7-5.4.6 Seals

Blast doors shall be provided with seals around the perimeter of the door. Blast door systems, including the seals, shall be gastight before and after an explosive detonation and fragmentation impact. The maximum leakage permitted around the seals is 1 standard cubic foot (28.3 liters) of air per hour per 1 linear foot (30.5 centimeters) of seal. Each blast door system shall be designed with the inherent capability to test leakage around the seals with the door and seals in place and without separate equipment or special procedures.

7-5.4.7 Hinge Requirements

The hinge design capacity shall be at least 150 percent of the calculated load to which the hinge will be subjected, including each component and mounting hardware. The life expectancy of the hinges shall be not less than 20 years, with a normal number of operating cycles per day based on a conservative evaluation of past facility operations (for existing facilities) or anticipated operations (for new facilities). The hinges shall allow the door to be adjusted in both the x- and y-axis of the door plane, which shall not require specialized tools, hinge disassembly, machining of hinge or door surfaces, cutting or welding, or any other such special procedures.

7-5.4.8 Equivalency to Fire Doors

NOTE: Cognizant Offices of Responsibility for this paragraph are AFCEC and AFSEC

In most cases, blast doors will be within fire-rated walls. Blast doors are not listed by nationally recognized testing laboratories as fire doors; however, based on their massive construction, they likely meet most of the listing agencies' criteria for a fire door. In cases where a blast door is within a fire barrier wall, a qualified fire protection engineer shall evaluate the door and determine if it meets the intent and function of a fire-rated door. The evaluation should include at least the types and amount of combustible materials used in construction of the door, a qualitative consideration of the door’s thermal transfer characteristics, the means of mounting the door into the blast wall and the door frame, and the size and means of sealing gaps around the door when closed. The evaluation shall be reviewed and approved by the Cognizant Office of Responsibility. If the evaluation proves that the door is not equivalent to a fire-rated door, other means shall be provided to ensure that the rating of the wall is maintained. Such configurations can include a fire-rated vestibule with fire-rated doors.

7-5.4.9 Communication Capability

Capability for communication by personnel shall be present on both sides of the blast doors.

7-5.4.10 Emergency Operation of Vertical Blast Doors

NOTE: Cognizant Offices of Responsibility for this paragraph are AFSEC and AF/A4S

If vertical blast doors are used, they shall be evaluated and configured such that in the event of an explosion within the space, the damaged door can be operated from the exterior of the room by an emergency means (e.g., providing the door with the necessary hardware to permit the use of a forklift to lift the door after an explosive event).

7-5.5 Blast Valves

NOTE: Cognizant Office of Responsibility for this paragraph is AFSEC

Blast valves shall be installed on HVAC hardened ducts and plumbing piping that penetrate blast-resistant barriers. These valves and their installation shall prevent over- and under-pressure blast waves from reaching the supply and exhaust airstreams. These valves shall be self-contained and capable of automatically closing upon an explosive event.

7-5.6 HVAC Systems

NOTE: Cognizant Offices of Responsibility for this paragraph are AFCEC and AFSEC

7-5.6.1 Zones

HVAC zones will be arranged to coincide with blast zones and fire areas to the maximum extent possible (refer to Chapter 11).

7-5.6.2 Valves

Blast valves and gastight butterfly valves will be used to isolate each ventilation air pipe crossing blast-resistant barriers. Butterfly valves (Wafer-Sphere®) shall be the quick-acting, gastight isolation type that are air driven, spring closed to isolate a zone immediately after an internal blast. Butterfly valves shall be triggered by blast detectors located within each contamination zone.

7-5.6.3 Hardened Duct

Hardened duct will be used for any duct penetrating a blast-resistant barrier or for any duct extending through a blast zone. Duct that remains entirely within a blast zone is not required to be a hardened duct.

7-5.6.4 Individual Air Handling Components

Each blast-protected containment zone will be served by individual air-handling components designed so that any contaminated air generated within that containment zone shall not be able to enter any containment zones or HVAC zones. Operation of any single blast containment zone shall not impair operation of the ventilation system for other containment zones or HVAC zones in the facility.

7-5.6.5 Ventilation Air Plenums

Ventilation air shall be supplied and exhausted through the blast wall from the mechanical plenums in either steel ducts or welded Schedule 40 steel pipes. The use of flexible ducts shall be permitted only with the approval of the Cognizant Office of Responsibility.

7-5.6.6 Containment of Blast Byproducts

The various weapon handling areas of the main facility will each be designed to contain the byproducts of an accidental explosion entirely within themselves until the byproducts can be safely vented outside.

7-5.7 Penetrations

Penetrations through blast resistant barriers include electrical conduit, hydraulic piping, compressed air piping, domestic water piping, floor drains, and water suppression piping. This list is not exhaustive. Penetrations will be limited to only those services necessary to serve that particular blast zone.

Wireways and cable trays shall not be permitted to cross the boundary of a blast containment zone (refer to Chapter 3).

7-5.8 Fire Sprinkler System

Remotely air-operated quick-acting isolation ball valves shall be placed on sprinkler lines for individual blast zones when it is necessary to prevent subsequent nuclear criticality events following a blast. These valves shall be configured to fail in the closed position. These valves shall also close at the same time as the blast valves. The valves shall be electrically supervised by the fire alarm system and initiate a trouble signal when closed.

7-5.9 Electrical

Explosion-proof conduit seals shall be provided for each conduit run passing through the boundary of a blast containment zone (refer to Chapter 3). Wireways and cable trays are not permitted to cross the boundary of a blast containment zone (refer to Chapter 3).

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CHAPTER 8 STUDIES AND DOCUMENTATION

8-1 SCOPE

This chapter provides criteria and requirements for conducting the specified studies in sufficient detail to ensure the safety of weapons and to provide baseline documentation to the Cognizant Office of Responsibility. The unique requirements for fire safety, including fire suppression systems and life safety components, are a key issue; however, principles of fire safety applicable to other types of facilities that handle special nuclear materials are available within certain national consensus standards and within the Department of Energy (DOE). Such principles were considered in developing this chapter.

The principles of facility safety, life safety, and fire protection required for nuclear weapons-capable maintenance and storage facilities were developed by collecting and refining criteria from DoD fire protection guidance, munitions safety guidance, and national consensus fire safety standards, including NFPA 801, NFPA 804, and NFPA 805. Also considered were DOE criteria, including DOE O 420.1C, DOE O 440.1B, and DOE-STD-1066-2012.

NOTE: Specific and unique fire protection and life safety criteria have been developed for nuclear weapons-capable maintenance and storage facilities. These criteria would not be appropriate for most DoD buildings. Consequently, the criteria in this document will take precedence in case of conflict with UFC-3-600-01.

8-2 APPLICATION

Studies will be accomplished on all nuclear weapons-capable maintenance and storage facilities as described in the following sections. Following the initial study efforts, if any proposed facility change or modification involves, affects, or impacts systems covered by the studies, they will be updated to include the effect of the modification on the study conclusions and recommendations.

These studies, new or revised, will be used to support or maintain facility certification actions. Facility certification actions will be accomplished in accordance with AFI 63-125.

8-3 FIRE HAZARD ANALYSIS (FHA)

NOTE: Cognizant Offices of Responsibility for this paragraph are AFNWC and AFCEC.

The purpose of the FHA is to comprehensively and quantitatively assess the risk from a fire originating from within individual fire areas in an Air Force facility to ascertain if Air Force fire safety objectives are being met.

8-3.1 FHA References

8-3.1.1 The FHA should include appropriate requirements and guidelines from the most current editions of the following publications:

- UFC 3-600-01
- NFPA 801
- AFMAN 91-201
- AFI 91-202
- Department of Defense Instruction (DoDI) 6055.06
- DoDD 6055.9E
- DoD 6055-09-M
- NFPA 550
- Society of Fire Protection Engineers (SFPE) *Handbook of Fire Protection Engineering*
- NFPA 13
- NFPA 14
- NFPA 72
- NFPA 101
- NFPA *Fire Protection Handbook*

NOTE: Other NFPA standards not included in this list should be considered, when appropriate.

8-3.1.2 With respect to nuclear weapons safety, security, and control, the FHA must be guided by the concepts and requirements contained in the most current edition of applicable publications, including, but not limited to:

- AFI 90-201
- Air Force Policy Directive (AFPD) 91-1
- AFI 91-101
- AFI 91-102
- AFI 91-103
- AFI 91-107
- AFI 91-116
- AFMAN 91-118
- DoDD 3150.02

- DoDM 3150.02
- DoD S-5210.41-M / AFMAN 31-108

8-3.2 Qualifications of FHA Personnel

8-3.2.1 The FHA will be accomplished by one or more qualified engineers.

8-3.2.2 At least one qualified engineer will be a fire protection engineer.

8-3.2.3 At least one qualified engineer will be an engineer who must meet one of the following conditions:

- At least five years of experience in design, construction, operations, or maintenance for civilian-owned or government-owned nuclear reactors or other nuclear facilities.
- At least five years of experience in design, construction, operations, or maintenance of US Navy nuclear-powered reactors.
- At least five years of experience in the design, commissioning, operations, maintenance, or de-commissioning of nuclear weapons.

8-3.2.4 A qualified engineer is defined as an individual meeting one of the following conditions:

- A registered professional engineer (P.E.) who has passed the engineering written examination administered by the National Council of Examiners for Engineering and Surveys (NCEES) in his or her area of expertise.
- An engineer who is not registered but can demonstrate a minimum of 10 years of documented engineering experience in his or her area of expertise, and who has been specifically approved by the Cognizant Offices of Responsibility to serve in the capacity of a qualified engineer.

8-3.2.5 The qualified engineer(s) will be supported by an engineering firm having experience in performing FHAs for a wide range and types of facilities and hazards—especially nuclear hazards. The engineering firm will have employees or ready access to individuals who are knowledgeable of nuclear facility operations, maintenance procedures, equipment design, training of facility personnel, and firefighting procedures. The engineering firm will have employees or ready access to individuals who are knowledgeable of issues unique to nuclear weapons-capable maintenance and storage facilities (e.g., security requirements versus life safety requirements).

8-3.2.6 The qualified engineer(s) accomplishing the FHA will obtain support from other appropriate engineering disciplines as needed, including, but not limited to, fire

protection, nuclear, electrical, mechanical, civil, structural, chemical, and systems engineers.

8-3.2.7 The qualified engineers accomplishing the FHA will consult with appropriate government or national laboratory representatives who are knowledgeable of weapon design and weapon system responses to ensure potential fires will not exceed weapon safety limits.

8-3.3 General FHA Considerations

8-3.3.1 Fire Areas

The focus of the FHA will be the individual fire areas. Fire areas are those areas of the facility that are bounded by fire barriers. Where a facility is not subdivided by fire-rated construction, the exterior walls and roof of the facility will define the fire area.

8-3.3.2 Conflicts

The FHA will identify specific sections of national consensus codes and standards that might be considered in conflict with the nuclear safety and security requirements of the facility. These will be documented within the FHA and alternative measures to achieve fire protection objectives will be recommended where appropriate.

NOTE: Conflicts between the specific requirements of this document and national consensus codes and standards are not required to be documented in the FHA.

8-3.3.3 Air Distribution Systems

The FHA must consider fire propagation and the potential for fire-induced radiological dispersal through the facility's air distribution system. These effects will be considered for both the normal operating mode of the air distribution system as well as operation in alternate modes, including system shutdown that may result from the fire.

8-3.3.4 Flammable and Combustible Materials

The quantity and associated hazards of flammable and combustible materials that can be expected to be found within the fire area will be factored into the analyses. Consideration must also be given to the presence of normal as well as unexpected transient combustible materials associated with the function and operation of the facilities.

8-3.3.5 High-Bay Locations

FHAs for high-bay locations will consider the effects of smoke and hot gas stratification that may occur at some intermediate point below the roof or ceiling. Similarly, the effect of smoke movement through doors and dampers held open by fusible links must be addressed. The impact of the height to automatic fire suppression and detection systems will also be evaluated. A fire model may be necessary to evaluate the response time of the suppression and detection systems at the ceiling of high-bay areas.

8-3.3.6 Natural Hazards

The FHA must consider natural hazards (e.g., earthquake, flood, wind, lightning, wild land fires) as related to their impact on fire safety within the facility.

8-3.3.7 Hostile Act Scenarios

The FHA will consider certain hostile act scenarios (defined by AF/A4SN) and their impact on fire-induced radiological dispersal.

8-3.3.8 Fire Models

Tools that will be used in the development of an FHA include fire models such as those developed by the National Institute of Standards and Technology (NIST); however, the use of such models is predicated on their being conservative and validated. Air Force acceptance of individual models will be considered on a case-by-case basis.

8-3.3.9 Fire Protection: Defense-In-Depth

Fire protection criteria are based on the principle of defense-in-depth. This document supplements and, in some cases, modifies the fire protection requirements of UFC 3-600-01 to meet the unique mission requirements of these facilities. Defense-in-depth is achieved when a balance of each of the following elements is provided in the facility:

- Preventing the initiation of fires
- Rapidly detecting all fires that do occur
- Controlling and promptly extinguishing fires to limit damage, personnel injury, and consequences to acceptable levels
- Providing a level of fire protection for structures, systems, and components so that a fire that is not promptly extinguished will not prevent essential facility functions from being performed and weapon safety limit from being exceeded

8-3.3.10 Life Safety Objectives

The FHA will analyze if life safety objectives are achieved, including:

- Any occupants that are not within the affected fire area are protected to a level such that they can safely exit the facility
- Occupants within the fire area must be protected to a level such that they have a reasonable expectation to safely exit the facility or be able to safely stay within a designated area of refuge
- Life safety configurations must also be arranged to provide adequate protection for essential and emergency response personnel

8-3.4 Determination of FHA Update for Existing Facilities

For existing facilities, the approved FHA will be evaluated by the owning facility program office no later than the end of the fifth calendar year after the date of the last FHA. If no changes have occurred to a maintenance or maintenance and storage facility's baseline configuration or maintenance concept of operations then the owning facility program office may defer the requirement for an FHA update for one additional five-year period by documenting that "no changes have occurred to the facility's baseline configuration or maintenance concept of operations" and update the existing approved FHA with that determination in a memorandum for record signed by the facility program office manager. If no changes have occurred to a storage-only facility's baseline configuration or storage concept of operations then the owning facility program office may continue to defer the requirement for an FHA update for additional five-year periods by documenting that "no changes have occurred to the facility's baseline configuration or storage concept of operations" in a memorandum for record signed by the facility program office manager. If it is determined that changes have occurred to the facility's baseline configuration then a FHA update will be required by a qualified engineer (see paragraph 8-3.5.3). Additionally, an updated FHA may be required when configuration changes are made to the existing facility's structure or systems if the changes have, or may have, impacted the facility's compliance with the fire prevention and fire protection requirements of this document. When updating the FHA for existing facilities, the qualified engineer(s) will contact facility personnel who are knowledgeable of facility maintenance, operations, equipment, training, and procedures. Additionally, the qualified engineer(s) will contact nuclear certification personnel at AFNWC/NTS, HQ AFGSC/A4C, HQ AFGSC/A4W and AFSEC/SEW.

8-3.5 FHA Content

8-3.5.1 Design FHA

During the design phase, the FHA for a new or existing facility must include an assessment of the risk from fire and related hazards (e.g., direct flame impingement, hot gases, smoke migration, firefighting water damage and drainage) in relation to existing or proposed fire safety features to ensure the facility can be safely controlled and stabilized during and after a fire. The Design FHA will be initiated early in the design phase to ensure an acceptable level of protection is being incorporated into the design. The Design FHA will be updated throughout the design phase as significant design changes occur that may affect any individual fire area. This Design FHA will serve as the basis document for the Post-Construction FHA. The level of detail necessary for an acceptable Design FHA is directly related to the complexity of the facility, the scope of the proposed design changes (for existing facilities), and the potential risk to the public and facility personnel. The scope and content of a Design FHA will be limited to those issues that are relevant to the facility. The Design FHA must comprehensively, qualitatively, and quantitatively accomplish the following:

8-3.5.1.1 Assess the potential and probability for fires within each new or modified fire area within a facility.

8-3.5.1.2 Evaluate the effects of possible fires and related perils (e.g., direct flame impingement, hot gases, smoke migration, firefighting water damage) in relation to the capabilities of fire safety features to ensure fire events can be safely controlled and stabilized for each new or modified fire area.

8-3.5.1.2.1 The evaluation will assume all potentially vulnerable systems will be damaged within the fire area. Acceptable exceptions to this assumption are water-filled steel pipes, tanks, and similar components of superior structural integrity with welded fittings and adequate pressure relief. Passive fire protection features, such as blank fire-rated walls, floors, and ceilings, and continuous fire-rated cable wraps, are assumed to remain viable.

8-3.5.1.2.2 The evaluation will determine the effect of possible fires when any single automatic fire detection or fire suppression system is not available to perform its intended function. Active fire protection features, such as fire dampers, window shutters, and self-closing fire doors in fire barrier walls, will also be evaluated using the criteria of a single fire protection feature not being available.

NOTE: This non-availability may result from an equipment failure (non-fire related) or because the fire occurs during a time the system has been disabled for routine maintenance.

If redundant automatic fire protection systems are provided in the area, only the one system or component that causes the most vulnerable condition need be assumed to be unavailable. Passive fire protection features, such as blank fire-rated walls, floors, and ceilings, and continuous fire-rated cable wraps, are assumed to remain viable.

8-3.5.1.3 Model the thermal parameters of fire events for each new or modified fire area that may contain a nuclear weapon and compare the results to weapons safety screening levels. Non-classified weapons safety screening levels (available from the government) must be used in the modeling.

8-3.5.1.4 Evaluate the impact of the facility fire protection and prevention system on nuclear criticality following the fire events and blast events (if applicable) for each new or modified fire area.

8-3.5.1.5 Model the fire events in each new or modified fire area designated as underground or limited egress areas and evaluate the safety to life for occupant egress, including the ability to use designated areas of refuge.

8-3.5.1.6 Establish the probability of resultant injuries to occupants for fire events within each new or modified fire area within a facility.

8-3.5.1.7 Establish the probability of damage to buildings or equipment for fire events within each new or modified fire area.

8-3.5.1.8 Evaluate the impact on mission continuity from the fire events for each new or modified fire area.

8-3.5.1.9 Quantify the costs related to fire damage to buildings or equipment from the fire events for each new or modified fire area.

8-3.5.1.10 For new facilities, determine the fire event creating the maximum credible fire loss (MCFL) and maximum possible fire loss (MPFL) for all analyzed fire events with respect to facility function as well as value.

8-3.5.1.10.1 In determining the MCFL, the basic assumption will be that automatic fire protection and suppression systems function properly as designed but that manual fire suppression activities are not possible for the first 30 minutes of the fire event in any controlled-access areas of the facility.

8-3.5.1.10.2 In determining the MPFL, which might be used by the government to assess the need for fire protection systems, the basic assumption will be that there is no automatic or manual fire suppression.

8-3.5.1.10.3 The loss determination for MCFL and MPFL must include all direct and indirect costs associated with the fire and clean-up operations. Clean-up costs due to radioactive contamination will be based on service-specific historical data or estimated from other historical data (e.g., data used by the DOE).

8-3.5.2 Post-Construction FHA

Prior to operation and certification of a new or modified facility, a Post-Construction FHA must be accomplished. The Post-Construction FHA must include at least the following:

- Evaluation of the as-built construction to ensure the validity of the Design FHA.
- Assessment of facility programs for minimizing the effects of fire on personnel, facilities, equipment, and mission.
- Assessment of organizational response, requirements, capabilities, training, and procedures as related to fire protection and response.
- Assessment of the adequacy of portable fire protection and prevention systems and equipment.

8-3.5.3 Updated FHA for Existing Facility

When required (see paragraph 8-3.4), an updated FHA for an existing facility will include at least the following:

- Evaluation of the design changes to the facility since the last FHA and the potential effects of those changes on nuclear surety and life safety.
- Evaluation of the potential effects of operational changes in weapons handling, maintenance, or storage since the last FHA.
- Assessment of any changes made to organizational response, requirements, capabilities, training, and procedures, as related to fire protection and response, since the last FHA.
- Assessment of any changes to facility programs intended to minimize the effects of fire on personnel, facilities, equipment, and mission since the last FHA.
- Assessment of any changes in portable fire protection and prevention systems and equipment since the last FHA.

8-3.6 Additional Considerations

The FHA must examine compliance and noncompliance in existing and post-construction facilities and will include these elements:

- Recommendations for correction or mitigation of noncompliance; the recommendations must identify specific mitigation strategies for the noncompliance (e.g., the need for a fire suppression system, the type of fire suppression needed, and the water requirement)
- For any noncompliance, the FHA will include a risk assessment of the noncompliance in case the recommendations are not approved for implementation
- Recommendations for improvement of features in compliance
- For recommendations for improvement of features in compliance, the FHA will include a qualitative risk assessment in case the improvement is not approved for implementation

Once approved by the Cognizant Offices of Responsibility, the results of the FHA will take precedence over previous or conflicting design criteria.

8-3.7 FHA Report

As a minimum, the FHA report must contain and document these items:

- All specific evaluations, modeling, analyses, considerations, and other requirements as detailed in paragraph 8-3 of this document
- A description and assessment of general facility construction, including the type, location, ratings (in hours), and construction of fire barriers

- A description and assessment of fire detection and fire suppression systems, equipment, and related components (including, but not limited to, HVAC systems)
- A description and assessment of fire hazards from adjacent facilities and construction, as appropriate
- An inventory of all priority electrical loads (e.g., fire alarm, emergency power) within the fire area that are susceptible to fire damage, including mechanical and electrical systems, which must function effectively during and after a fire event; this will also include an assessment of the adequacy and protection afforded these priority electrical loads
- Critical transformers that, if lost, would have a severe impact on the facility mission
- Emergency lighting illumination levels for security staging and operating locations and firefighting staging and operating locations
- An evaluation of the potential for flame spread, fire spread, and smoke development due to cabling within the facility with respect to the requirements in Chapter 3
- An assessment of fire response and fire response plans, including organization, capabilities, training, and requirements
- An itemization of areas and issues of noncompliance, including the comprehensive and qualitative risk assessment of the noncompliance items if not accomplished
- An itemization of areas and issues in compliance that are recommended as candidates for improvement
- Recommendations for correction or mitigation of noncompliance
- Recommendations for action on candidates for improvement
- A description of any critical process equipment
- A description of any high-value property
- The potential for a toxic, biological, or radiological incident due to fire
- Life safety considerations
- Emergency planning
- Recovery potential
- Exposure to fire potential and the potential for fire spread between two fire areas

8-3.8 Implementation of FHA Results

Project requirements for existing buildings and design adjustments for new facilities are developed based on the results of the FHA or other analyses performed on existing structures and approved by the Cognizant Offices of Responsibility. To the greatest extent practical, the level of protection for existing and new structures should be identical; however, implementing current levels of protection into all existing structures will not be feasible. In these cases, a technical evaluation or other approved analysis can provide to the Cognizant Offices of Responsibility a suitable justification for the acceptability of the existing configuration.

8-4 EMRE SURVEY

NOTE: Cognizant Office of Responsibility for this paragraph is AFSEC.

An EMRE survey is a comprehensive assessment of the EMRE within each facility to ensure that exposures of weapons systems to the EMRE from all equipment installed or used within the facility, individually and collectively, does not result in an overall EMRE that exceeds the weapons stockpile-to-target sequence (STS) levels. The EMRE survey will meet or exceed the requirements and guidelines of the most current edition of AFMAN 91-118, Section 2I, paragraph 2.45.9, and Section 4H, paragraphs 4.8.1.7 and 4.8.1.10 (see paragraph 8-4.1 of this document for other references).

NOTE: An EMRE survey is typically funded by the facility occupant.

8-4.1 EMRE References

The EMRE survey must meet or exceed the requirements and guidelines of the most current edition of these publications. (Other publications may also apply.)

- AFMAN 91-201
- DoDD 6055.9E
- DoD 6055-09-M

The EMRE survey will consider the concepts and requirements with respect to nuclear weapons safety, security, and control as contained in the most current edition of these publications. (Other publications may also apply.)

- AFI 90-201
- AFPD 91-1
- AFI 91-101
- AFI 91-102
- AFI 91-103
- AFI 91-107

- AFI 91-116
- AFMAN 91-118, Section 2I, paragraph 2.45.9, and Section 4H, paragraphs 4.8.1.7 and 4.8.1.10
- DoDD 3150.02
- DoDM 3150.02

8-4.2 Qualifications of Survey Personnel

EMRE calculations (straw-man analysis) during project design should be performed by the electrical engineer on the project.

EMRE surveys for background or at facilities will be accomplished by the 85th Engineering Installation Squadron (EIS) Specialized Engineering Flight, Keesler Air Force Base, Mississippi.

8-4.3 Survey Frequency

8-4.3.1 New Facilities

On all new facilities, a background EMRE survey will be accomplished at the beginning of the design process at the site where the facility is to be built.

During design, analyze anticipated EMRE emitters using straw man data to project anticipated EMRE levels and to adjust facility design, equipment selection, and procedures as necessary to reduce EMRE levels. In these cases, the survey will consist of an analysis of anticipated EMRE emitters using straw man data to project EMRE levels.

8-4.3.2 Post-Construction Survey

Conduct a complete EMRE survey upon activation of the facility to ensure actual levels do not exceed maximum permitted EMRE values.

8-4.3.3 Existing Facilities

The EMRE survey will be accomplished on any existing facility when configuration changes are made to the facility or facility systems or changes are made in the tools and equipment that impact the EMRE. The EMRE survey will help ensure the overall EMRE, as a result of such changes, does not exceed the weapon's STS levels.

8-4.3.4 Renewal

The EMRE survey will be updated on all facilities no later than the end of the fifth calendar year after the date of the last EMRE survey.

8-4.4 EMRE Survey-Specific Requirements

8-4.4.1 EMRE Survey Elements

The EMRE survey must:

8-4.4.1.1 Accomplish discrete tests of all unintentional EMRE emitters used in close proximity to critical equipment within the facility. These unintentional EMRE emitters include, but are not limited to, fluorescent lighting; motors; hand tools; computers and monitors; communication equipment such as phones and intercoms; entertainment devices such as televisions, MP3 players, and radios; and fire alarm control panels.

8-4.4.1.2 Accomplish discrete tests of all intentional EMRE emitters used in close proximity to critical equipment within the facility. These intentional EMRE emitters include, but are not limited to, computers using wireless devices or networks; radio transmitters; motion sensors; and “lossy” antenna distribution systems.

8-4.4.1.3 Measure ambient levels in representative areas and measure specific classes of emitters used in close proximity to critical equipment.

8-4.4.1.4 Perform an external ambient survey outside of the facility to obtain an overview of the typical EMRE levels encountered in the nearby area.

8-4.4.1.5 Evaluate and analyze the results to determine compliance with AFMAN 91-201. Identify compatibility anomalies and make recommendations for mitigating these anomalies.

8-4.4.2 EMRE Survey Report

As a minimum, the EMRE survey report must contain and document these items:

- A detailed list of test equipment with calibration dates
- A detailed list of the equipment tested (including locations, if appropriate for the equipment)
- A testing strategy and survey plan
- A graphical comparison of EMRE from tested equipment in comparison to appropriate STS curves
- A simulated composite EMRE environment to determine the maximum practicable level that could be expected
- Conclusions on any findings and recommendations for corrective measures

8-5 FACILITY CHARACTERIZATION

NOTE: Cognizant Office of Responsibility for this paragraph is AFSEC.

8-5.1 General Requirement

Facility characterization will meet the criteria and requirements of Chapter 2.

NOTE: Facility characterization may be accomplished when deviation from the seven-foot rule as defined in AFMAN 91-201 is proposed. Facilities that have not been characterized must comply with the seven-foot rule. Any deviation from the seven-foot rule requires specific approval of the Cognizant Office of Responsibility.

8-5.2 Specific Requirements

8-5.2.1 Facility characterization will be accomplished:

- By the 85th EIS Specialized Engineering Flight, Keesler Air Force Base, Mississippi
- On all new facilities upon completion of the facility construction
- On existing facilities when specifically approved by the Cognizant Office of Responsibility
- On any facility that has been previously characterized and when configuration changes to the facility or facility systems are made that may have impacted the facility characterization requirements of this document. A qualified electrical engineer will determine if a total or partial revision to the previous facility characterization is required.

8-5.2.2 Facility characterizations will be updated on all facilities no later than the end of the tenth calendar year after the date of the last facility characterization.

8-5.2.3 On facilities that have been characterized, comply with the requirements in AFMAN 91-201, including the requirements for periodic maintenance and inspection. This must include retesting the Faraday shield, bonding, and surge suppression features.

8-6 FIRE DEPARTMENT BASELINE NEEDS ASSESSMENT

NOTE: Cognizant Office of Responsibility for this paragraph is AFCEC.

8-6.1 Baseline Needs Assessment

The base fire department must have a baseline needs assessment that establishes the minimum required capabilities of base firefighting forces. This includes minimum staffing, apparatus, facilities, equipment, training, fire pre-plans, off-site assistance requirements, and procedures. Information from this assessment will be incorporated into the site emergency plan. Baseline needs assessments are approved by the Cognizant Offices of Responsibility.

8-6.2 Updates

Baseline needs assessments for firefighting forces are periodically performed through independent assessors who are regarded as experts in the field. Frequencies of updates are not formally established but updates are performed when there is a significant change in base or facility mission, size, or hazards.

8-7 FIRE PREVENTION PROGRAMS

NOTE: Cognizant Office of Responsibility for this paragraph is AFSEC.

Nuclear weapons-capable maintenance and storage facilities will implement fire prevention programs. Such programs can be part of an overall base fire prevention program or be established as a specialized program for the facility.

At a minimum, the fire prevention program must include:

- Fire department inspections
- Combustible loading limitations and inspections
- Storage criteria
- Use and handling of flammable and combustible liquids
- Use of heat-producing appliances
- Hot work and hot work permits
- Roofing operations permits
- Use of fuel-fired heaters and equipment

8-8 FIRE PROTECTION IMPAIRMENTS AND DEFICIENCIES

NOTE: Cognizant Office of Responsibility for this paragraph is AFCEC.

Nuclear weapons-capable facilities will have implemented fire protection impairment and deficiency programs. These programs can be part of an overall base impairment and deficiency program or be established as a specialized program for the facility.

The programs must include the identification, tagging, and tracking of impaired equipment, and the determination of compensatory fire protection and prevention measures.

The programs will comply with AFI 32-10141.

8-8.1 Application

The programs must apply to all active fire protection systems, including automatic sprinkler systems, fire detection systems, filter plenum fire suppression, and special hazard suppression systems. The application of the program to passive fire protection systems, including fire barriers, dampers, lightning protection components, and fire extinguishers, and to any work activities not directly related to active fire protection systems, may be included at the discretion of the facility manager unless otherwise directed by the Cognizant Offices of Responsibility.

8-8.2 Tracking Requirements

A fire protection system impairments and deficiencies program will be used to track and trend all system failures, planned outages, minor system discrepancies, or removal of systems from active service. Systems removed from service for the purpose of facility demolition must be tracked until demolition completion.

8-8.3 Impairment Coordinator

The facility user will designate an impairment coordinator to track impairments and deficiencies.

CHAPTER 9 FIREFIGHTING GUIDANCE

NOTE: Cognizant Office of Responsibility for this chapter is AFCEC.

9-1 SCOPE

This chapter provides criteria and requirements for developing detailed pre-fire plans. Pre-fire plans are also known as pre-incident plans and the terms can be used interchangeably.

9-2 DEVELOPMENT OF PRE-FIRE PLANS

Detailed pre-fire plans will be developed for all facility areas. The plans will detail the fire area configurations and fire hazards along with any nuclear weapon-related components and fire protection systems and features. Pre-fire plans will be reviewed and, if necessary, updated at least every two years. Pre-fire plans will be available in the security control room.

In developing a schedule for pre-fire plans, these items will be considered:

- Potential life safety hazard
- Facility size and complexity
- Value
- Mission importance
- Presence of hazardous materials
- Susceptibility to natural phenomena

The emergency response organizations must be trained to the pre-fire plan program as well as the individual pre-fire plans.

9-3 ELEMENTS OF PRE-FIRE PLANS

The physical elements of a pre-fire plan are addressed in paragraphs 9-3.1 through 9-3.9.9.

9-3.1 Internal Site Conditions

9-3.1.1 Construction and Building Features

Include information on these features:

- Construction, floor construction, construction of interior walls, suspended ceiling assemblies, raised floors, concealed spaces, windows for rescue, confined space, and fire resistance of structural members
- Area and height

- Building services, including utilities (electric, transformers, emergency power, domestic water, compressed and liquefied gases, steam, and fuels)
- Building features: the structural integrity of walls, roofs, and floors, including added live and dead loads; indications of deterioration and structural weakening and other conditions that would impact fire spread; ability of responding personnel to access the building; and the potential for falling debris

9-3.1.2 Occupant Considerations

The number and type of occupants in a facility will have a substantial impact on the pre-fire plan. Critical information to be gathered includes the expected number of occupants and their duties within the facility.

9-3.1.3 Life Safety Considerations

Life safety considerations are a priority that must be addressed to permit responding emergency service personnel to assist immediate and safe evacuation of facility personnel. Considerations must also be included on the actions of the facility security personnel and their duties during emergency events.

Unique life safety egress facility configurations must be documented within the pre-fire plan.

9-3.2 External Site Conditions

9-3.2.1 Fences

The height and construction of fences will be noted. Security measures for these fences will also be included.

9-3.2.2 Exposures

The grounds surrounding the facility will be evaluated to identify buildings, structures, equipment, and storage that could be exposed by an incident.

9-3.3 Communications Impact

Include the results of a functional test of the communications system as it will be used in an emergency. This information is critical for many of the unique facilities across the Air Force.

Data regarding communications impact that will be recorded include the following:

- Interference or poor coverage as a result of construction or radio system design, including coverage in below-grade and shielded areas, interiors of large structures, and the upper floors of high-rise buildings
- Assignment of radio channels
- Other supplemental communications available within or external to the facility

9-3.4 Security Data

Information about security measures will be included to ensure prompt ingress to the facility at all times on a need-to-know basis. Comply with security classification requirements for the installation.

9-3.5 Personnel Interactions

The interaction between firefighting personnel and the facility and external security personnel must be addressed within the pre-fire plan. In a number of situations, fire forces and security forces may have conflicting missions during an emergency. These situations must be addressed within the pre-fire plan so agreements between the two groups may be established in advance. It is also advisable to practice drills that implement these agreements to ensure they can be carried out in the proper manner.

9-3.6 Defend-in-Place Methods

Defend-in-place methods to be used because complete evacuation is either impossible or impractical will be noted within the pre-fire plan. Comply with security classification requirements for the installation.

9-3.7 Hazards Information

9-3.7.1 Hazardous Materials Coordinator

If a facility has an individual or department that is responsible for maintaining material safety data sheets (MSDS) and inventories of hazardous materials, the pre-fire plan will contain information on contacting this individual. If a facility or base has an internal computer-based hazardous materials system, means to access this system will be detailed within the plan.

9-3.7.2 Special Hazards

Special hazards within the facility will be documented. These hazards may include flammable and combustible liquids, explosives, toxic agents, radioactive materials (ionizing radiation and contamination), reactive chemicals, electrical and mechanical hazards, and special hazards.

9-3.8 Incident Operations

The plan will address the standard response to the facility and the incident command system as it applies to the building.

9-3.9 Fire Protection Systems Information

Information on fire protection systems (detection and suppression) will be determined in the development of the pre-fire plan. The required information is addressed in paragraphs 9-3.9.1 through 9-3.9.9.

9-3.9.1 Information on Primary Water Supply

Included will be the required fire flow for the building based on criteria developed in the approved FHA. Evaluation of the water supply may require testing of the water system or obtaining information from the installation engineering branch.

9-3.9.2 Fire Department Connections (FDC)

Data concerning the FDCs will be included within the plan. The information required is the physical location, areas covered, and the type of system supplied.

9-3.9.3 Fire Pumps

Data regarding facility fire pumps will be provided that includes the location, type of driver, capacity, water source, operation (automatic, manual, or remote manual), areas served, and contact information for the department responsible for maintenance and operation during an emergency.

9-3.9.4 Fire Hydrants

Data regarding facility fire hydrants will be provided that includes the location and type of each hydrant, number and diameter of each outlet, size of the water main location, and the approximate flow at 20 pounds per square inch gauge (psig) (138 kilopascals gauge).

9-3.9.5 Automatic Sprinkler Systems

Data concerning automatic sprinkler protection will be documented, including the type of system (wet, dry, pre-action), hazard classification of the system and occupancy, location of all controlling valves for the system, location and identification of all risers, location of audible flow alarms, and extent of the sprinkler coverage.

9-3.9.6 Standpipe System

Data concerning standpipe systems will be documented that includes the type of system, location and size of outlets, pressure available at the hose outlets, water supply, location of isolation valves, and the location and identification of all risers.

9-3.9.7 Protective Signaling Systems

Data for the facility fire alarm systems will include the method of system activation, areas of coverage, location of the fire alarm control panel and the remote fire alarm panels, type of detectors, any public address system or voice alarm capability, and the method and extent of occupant notification. Information on the DoD-required mass notification system (MNS) will be included, including details on the configuration of the system (e.g., combination system with the fire alarm system or stand-alone system).

9-3.9.8 Special Hazard Protection Systems

Data for special hazard fire protection systems that will be included within the pre-fire plan include the type of system, hazard, or area protected by the system, location of control panels, activation method, personnel hazards of the protective agent (if any), and method and extent of occupant notification.

9-3.9.9 Smoke Management

Data regarding any smoke management systems will be included. This may include the type of system, location of the areas served by the system, and location of the primary control panel for the system. This will also include any portable ventilation equipment or systems (see Chapter 12).

9-4 ROBOTIC FIREFIGHTING RESPONSE VEHICLES

The use of robotic firefighting response vehicles located within areas capable of maintaining or storing nuclear weapons may be considered when necessary to reduce the response time to an incident. Use of such vehicles is not a general practice and must not be implemented without prior approval of the Cognizant Office of Responsibility. Requests to use robotic firefighting methods will evaluate operational impacts such as training, staffing levels, initial and recurring equipment costs, required supplies and costs, environmental impacts, EMRE, and other related issues.

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CHAPTER 10 TEMPORARY INTERIOR CONSTRUCTION

NOTE: Cognizant Office of Responsibility for this chapter is AFSEC.

10-1 SCOPE

This chapter provides criteria and requirements for temporary interior construction. For the purposes of this document, “temporary” is defined as any structure in place for less than 12 months. Any temporary construction features not covered by this chapter will, by default, be required to meet the criteria of permanent construction.

10-2 FIRE-RETARDANT WOOD

If wood is used for interior temporary construction, the wood must be noncombustible, limited-combustible, or fire-retardant, pressure-impregnated wood. Fire-retardant coatings are not acceptable on walking surfaces or surfaces subject to mechanical damage. Industrial safety personnel will be contacted prior to coating scaffolding with a fire-retardant coating since the coating may have an effect on the wood that must be evaluated.

10-3 FIRE-RETARDANT TARPAULINS

The use of interior temporary coverings will be limited to special conditions for which interior temporary coverings are necessary, e.g., contamination control structures (interior tents). They must be constructed of approved fire-retardant plastics or tarpaulins and meet the testing requirements of NFPA 701.

10-4 FIRE EXTINGUISHERS

All interior temporary construction must have the appropriate type and size of portable fire extinguisher, spaced in accordance with NFPA 10.

10-5 TEMPORARY ELECTRICAL WIRING

The potential for ignition of flammable materials will be minimized by requiring that all temporary electrical wiring:

- Be kept to a minimum
- Be suitable for the location
- Be installed and maintained in accordance with NFPA 70 or IEEE C2, as appropriate
- Be arranged so energy can be isolated by operation of a single switch
- Be arranged so energy can be isolated when not needed

10-6 TEMPORARY HEATING APPLIANCES

10-6.1 Types Permitted

Only safely installed, approved, electrically powered heating devices will be used in all locations. All heating devices must comply with AFI 91-203.

10-6.2 Automatic Shutdown Feature

Heating devices must be situated so they are not likely to overturn and will be provided by the factory with an automatic shutoff feature per AFI 91-203.

10-6.3 Monitoring and Maintenance

Temporary heating equipment, when used, will be monitored and maintained by properly trained personnel.

10-7 PLASTIC SHEATHING

If plastic sheathing is used for temporary construction or containment structures (plastic tents), it must meet the testing requirements of NFPA 701.

CHAPTER 11 FIRE PROTECTION SYSTEMS

NOTE: Cognizant Office of Responsibility for this chapter is AFCEC.

11-1 SCOPE

This chapter includes the criteria and requirements for fire detection, fire suppression, fire alarm, and mass notification systems (MNS) applicable to nuclear weapons-capable maintenance and storage facilities.

11-2 GENERAL REQUIREMENTS

Fire protection systems will be designed in accordance with UFC 3-600-01, except as modified in this document.

Fire suppression and fire detection systems will be configured to coincide with the blast zones (if provided) and HVAC zones unless approved by the Cognizant Office of Responsibility.

NOTE: This requirement is intended to reduce the number of penetrations through the blast walls by the fire protection equipment and may also improve the survivability of the fire protection systems.

11-3 LISTED EQUIPMENT

Fire protection equipment must be listed or approved for its intended service by a nationally recognized testing laboratory (NRTL), except for certain equipment for which such listing or approval is not practical because of the unique nature of nuclear weapons-capable facilities. For example, a blast door or security door, by nature of its construction, might serve adequately as a fire door but has never been listed or approved for such a purpose. In these cases, the use of non-listed or non-approved equipment will be approved by the Cognizant Office of Responsibility.

11-4 WATER SUPPLIES

11-4.1 Two Independent Sources

At least two independent sources of water must be provided, each of not less than 300,000 gallons (1,135,600 liters). A water supply independent of the potable water supply is not required for water-based fire suppression systems unless so specified in the FHA. Examples of independent water supply systems include:

- Base/municipal potable water system capable of supplying not less than 300,000 gallons (1,135,600 liters) in one elevated tank (can count as one independent source of water)

- Base/municipal potable water system capable of supplying not less than 300,000 gallons (1,135,600 liters) in each of two or more elevated tanks (can count as two independent sources of water)
- Base/municipal potable water system supplied by a reservoir exceeding 1,000,000 gallons (3,785,400 liters), with at least two independent supply connections from the reservoir to the potable water system (can count as two independent sources of water)
- One elevated water tank with a capacity of 300,000 gallons (1,135,600 liters) (can count as one independent source of water)
- Several smaller elevated water tanks with a combined capacity of 300,000 gallons (1,135,600 liters) supplying the same water main (can count as one independent source of water)
- Two elevated water tanks, each with a capacity of 300,000 gallons (1,135,600 liters) (can count as two independent sources of water)
- Two ground-level water tanks, each with a capacity of 300,000 gallons (1,135,600 liters), with dedicated fire pumps (can count as two independent sources of water)
- Pressure tanks internal to the facility (e.g., when the FHA permits a tank volume of less than 300,000 gallons [1,135,600 liters]).

11-4.2 Interconnection

The water supplies must be interconnected such that if fire pumps are used, they can take suction from any source. A failure in one source must not cause both sources to fail.

11-4.3 Replenishing Supply

The water source for replenishing the supply for fire protection in at least one tank must be capable of restoring the tank within an eight-hour period.

11-4.4 Multiple Water Supplies

If multiple water supplies are used, each water supply must be connected to the fire main by a separate connection that is arranged and valve-controlled to minimize the possibility of multiple supplies being simultaneously impaired. Generally, the two supplies should be connected such that they are hydraulically remote from each other.

11-4.5 Water Supply Limitations

Provide a water supply that will not be susceptible to bio-fouling, scaling, microbiologically induced corrosion (MIC), or sedimentation. The tanks must not be supplied by an untreated, raw water source.

11-5 FIRE SUPPRESSION SYSTEMS

11-5.1 Water-Based Fire Suppression Systems

An automatic water-based suppression system will be provided in all areas of the facility and must be designed to control and suppress a fire based on the fire hazard in each area. This analysis will be included in the FHA. Refer to Chapter 12 for fire suppression systems installed to protect filters that collect combustible material.

NOTE: Based on the hazards generally found within nuclear weapons-capable maintenance and storage facilities, it is expected that a wet-pipe type of automatic sprinkler system or water mist fire suppression system will be needed in most areas, with a dry-pipe type of system used in those areas subject to temperatures below or approaching freezing (e.g., truck bays, earth-covered magazines). Firefighting foam-based fire suppression systems are expected to be required in special areas such as refueling areas or areas where the FHA identifies hazards from combustible or flammable liquids.

11-5.1.1 Hardening of System

Suppression systems in weapon handling areas must be hardened against possible internal or external damage to the building (e.g., breach control valves, redundant sprinkler headers). See Chapter 7 for additional requirements for individual blast zones when it is necessary to prevent subsequent nuclear criticality events following a blast.

NOTE: Appendix B provides guidance on the selection and design of hardened fire protection systems.

11-5.1.2 Calculations

Domestic water distribution systems that also serve fire protection requirements will be designed to simultaneously meet the calculated fire protection demand (e.g., sprinklers and hose streams) and the peak domestic demand. When not otherwise identified, the peak domestic demand will be calculated as 2.5 times the calculated average daily demand plus appropriate special demands. The domestic water distribution system will be capable of meeting this combined demand at a minimum residual pressure of 20 pounds per square inch (psi) (137.9 kilopascals) at ground elevation for a period of not less than two hours.

11-5.1.3 Looped System

Water-based fire suppression systems must be looped with at least two independent means of water supply into the fire suppression system. The supply points must be separated so that external damage to one supply point (e.g., mechanical damage by a backhoe) must not simultaneously damage other supply points. This separation will be no less than 20 feet (6.1 meters).

11-5.1.4 Piping Under Buildings

Water supply piping must not be located under buildings. The water distribution piping to a building may penetrate the building slab at a location as close as practical to the building's exterior wall.

11-5.1.5 Sectional Control Valves

Sectional control valves will be provided to isolate damaged portions of the looped fire suppression system while permitting undamaged portions to remain in service.

11-5.1.6 Outside Screw and Yoke (OS&Y) Valve

In addition to an exterior isolation valve, each system must be equipped with an approved OS&Y gate valve or other approved interior isolation valve.

11-5.1.7 Location of Risers and Alarm Valves

Sprinkler system risers and alarm valves will be located as close as practical to a building or fire zone entry point intended for access by responding emergency service personnel.

11-5.1.8 Independence

The piping serving each zone of an automatic water-based suppression system must be independent from piping to other zones.

11-5.1.9 Alarm Annunciation

Each fire suppression system will be equipped with approved alarming devices that will annunciate an alarm in a constantly attended area (e.g., installation fire department) and will activate internal and external fire alarms in the facility.

11-5.1.10 Domestic Water

Within the facility, domestic water will be supplied to the greatest extent practical by a separate service line and not be designed as a combined fire protection and potable water service or as a combined process and potable water service. Where combined fire and domestic-process water systems are necessary (e.g., to reduce penetrations through blast containment walls), the distribution piping must be provided with isolation valves so domestic or process systems can be isolated from the fire protection system.

11-5.2 Foam Fire Suppression Systems

Foam fire suppression systems designed in accordance with NFPA 11 will be used where flammable or combustible liquids are of significant concern and in other areas as specified in the FHA.

11-5.3 Water Mist Systems

Water mist systems designed in accordance with NFPA 750 will be used in nuclear weapons-capable maintenance and storage facilities in lieu of automatic sprinklers when specified in the FHA.

11-5.4 Fire Suppression Systems for Specific Hazards

11-5.4.1 Enclosed Vehicle Loading Docks

Enclosed vehicle loading docks must be provided with automatic fixed water-based suppression systems. Automatic sprinkler systems must be designed for a density of no less than 0.30 gallon per minute per square foot (12.2 liters per minute per square meter). The area of the entire vehicle loading dock or 5000 square feet (465 square meters) (whichever is less) will be considered the sprinkler design area unless otherwise approved by the Cognizant Office of Responsibility.

NOTE: Generally, it is expected that these enclosed vehicle loading docks will be protected with dry-pipe sprinklers.

11-6 SEISMIC CAPABILITIES

The water supply systems will be capable of supplying water to automatic water-based fire suppression systems, standpipes, and hose stations in all areas designated for the transportation, storage, and maintenance of nuclear weapons following a design basis earthquake.

11-7 SUPPLY MAINS AND HYDRANTS

11-7.1 Yard Fire Main Loop

11-7.1.1 Design and Installation

An underground yard fire main loop will be designed and installed in accordance with NFPA 24. The loop will be sized to accommodate emergent mission requirements.

Design of the pipe and provision for water treatment must consider the potential for tuberculation and MIC. Means for easily inspecting and flushing the systems will be provided.

11-7.1.2 Isolation

Means will be provided to isolate portions of the yard fire main loop for maintenance or repair without simultaneously shutting off both supplies to fixed fire suppression systems and fire hose stations. Approved visually indicating sectional control valves such as post-indicator valves will be provided to isolate portions of the main for maintenance or repair. Isolation valves must be configured so that no more than five connections (sprinkler systems, hydrants, or hose connections) are impaired at any one time.

11-7.1.3 Headers

Each automatic suppression system and standpipe will be supplied from two physically separated headers supplied by the yard fire main loop. Schedule 40 or thicker steel piping and fittings meeting the requirements of American Society of Mechanical Engineers (ASME) B31.1 will be used above ground for the headers (up to and including the first valve) supplying the automatic suppression systems where such headers are part of the seismically analyzed hose standpipe system. Where provided, such headers will be considered an extension of the yard main system. Each sprinkler and standpipe system will be equipped with an OS&Y gate valve or other listed or approved shutoff valve.

11-7.2 Hydrants

11-7.2.1 Location

Hydrants will be located every 250 feet (76 meters) apart on the yard main system when the yard loop also supplies water to above-ground buildings that support the underground facility. Valves will be installed to permit isolation of outside hydrants from the fire main for maintenance or repair without interrupting the water supply to automatic or manual fire suppression systems.

11-7.2.2 Compatibility

Threads compatible with those used by local fire departments will be provided on all hydrants.

11-8 STANDPIPES AND HOSE STATIONS

11-8.1 Standpipe Locations

Class I dry standpipes designed in accordance with NFPA 14 will be provided within each fire area and within each enclosed vehicle loading dock.

11-8.2 Standpipe Connections

Fire department connections to the standpipes will be located near the locations of entry to the fire area that will be used by emergency responders. Connections will be

provided in stairwells in multi-story facilities. The size and type of threads on the standpipe connections must be compatible with the equipment used by the fire department. A fire hose station will be installed immediately outside of the security control room (see Chapter 5).

11-8.3 Hose Station Locations

Hose stations or a mobile means of providing hose and associated equipment, such as hose carts or trucks, will be provided in all fire areas designated for the transportation, storage, or maintenance of nuclear weapons.

11-8.4 Water Flow Rate and Nozzle Pressures

Water flow rate and nozzle pressures as determined in the FHA must be provided to hose stations.

NOTE: Hose station pressure reducers may be needed for the safety of fire department personnel as specified in the FHA.

11-8.5 Hose Nozzles

The types of hose nozzles to be located at each hose station will be based on the fire area's particular fire hazards and on the operational requirements of the fire department. Hose nozzles must have shutoff capability and be able to control water flow from fully open to fully shut. Hoses and nozzles may be omitted at locations where so documented in the FHA.

NOTE: The commonly used combination spray and straight-stream nozzle should not be used in areas where a straight stream could cause unacceptable damage or create an electrical hazard to firefighting personnel. Approved electrically safe, fixed fog nozzles should be provided at locations where high-voltage electrical shock hazards could exist.

11-9 VALVES

11-9.1 Inspection and Supervision

All fire protection water supply and fire suppression system control valves must be supervised by one of the following methods:

- Electrical supervision with audible and visual signals in the security control room or other suitable constantly attended location.
- Locking valves in their normal position when so documented in the FHA. Keys will be controlled and made available only to authorized personnel.
- Sealing valves in their normal positions when so documented in the FHA. This option will be utilized only where valves are located within fenced areas or under the direct control of approved facility personnel.

11-9.2 Operators

Operators (e.g., hand wheels) of valves that require manual manipulation must be readily accessible. If the hand wheel is located more than 5 feet (1.5 meters) above the floor or ground, the hand wheel must be provided with either a chain operator or a permanent platform. The platform must be of sufficient size to allow the operator to safely perform the manual action.

11-10 FIRE PUMPS

Fire pumps are not required for nuclear weapons-capable maintenance and storage facilities when reliable means of meeting the fire protection demands are provided and when the omission of the fire pumps is approved by the Cognizant Office of Responsibility.

11-10.1 Design and Installation

Fire pumps must be designed and installed in accordance with NFPA 20 to ensure that at least100 percent of the required flow rate and pressure are available, assuming failure of the largest pump or pump controller. The flow requirements will be met based on 100 percent of the capacity of the pump (not 150 percent as is commonly used in other types of facilities).

11-10.2 Configuration

11-10.2.1 Multiple Facilities

Fire pumps may be configured to serve more than one nuclear weapons facility when approved by the Cognizant Office of Responsibility.

11-10.2.2 Number of Pumps

For maximum reliability, three fire pumps will be provided so that two pumps meet the maximum demand plus hose streams. When approved by the Cognizant Office of Responsibility, use of two fire pumps is an acceptable alternative, provided either of the fire pumps can supply the maximum demand plus hose streams at no more than 120 percent of the fire pump’s rated capacity.

11-10.2.3 Flow Testing

Fire pumps will be configured to permit ease of flow testing. Provide a test discharge header that is piped back into the tank or provide piping to a location where the test nozzles can be flowed with minimal operational impact (e.g., into a pond or open field).

11-10.2.4 Separation of Pumps

Each pump and its driver and controls must be separated from other fire pumps by 2-hour-rated fire barriers and also from the rest of the facility by 2-hour-rated fire barriers.

11-10.2.5 Manual Shutdown

Fire pumps must be provided with automatic start but only manual shutdown. The manual shutdown must be located at the pump controllers. A remote manual start is permitted in addition to the automatic start.

11-10.2.6 Sectionalizing Valves

Individual fire pump connections to the yard fire main loop will be provided and separated with sectionalizing valves between connections such that loss of one fire pump connection to the loop can be isolated without isolating the other pumps.

11-10.2.7 Jockey Pump

A method of automatic pressure maintenance of the fire protection water system (commonly referred to as a jockey pump) must be provided independent of the fire pumps.

11-10.2.8 Alarm Annunciation

Means will be provided to immediately notify a constantly attended location (e.g., installation fire department) of the operation, failure, or receipt of supervisory signals of the fire pumps.

11-11 GASEOUS FIRE SUPPRESSION SYSTEMS

An automatic total flooding or local application gaseous fire suppression system may be installed to supplement but not replace the required automatic water-based suppression system. The requirement for such a system must be approved by the Cognizant Office of Responsibility for the protection of unique situations or to address unique hazards. The system will be designed and installed in accordance with NFPA 2001.

11-11.1 Annunciation

Operation of gaseous fire suppression systems will annunciate an alarm in a constantly attended location.

11-11.2 Ventilation System Design

Ventilation system design must prevent space over-pressurization during agent injection and provide adequate sealing to prevent loss of agent.

11-11.3 Disarming Device

Provisions for locally disarming automatic gaseous suppression systems will be secured and maintained under strict administrative control. Activation of the disarming device will initiate a supervisory alarm on the fire alarm control panel.

11-11.4 Prohibited Systems

Installation of carbon dioxide, Halon 1211, and Halon 301 systems are prohibited.

11-11.5 Global Warning Potential

Procurement of hydrofluorocarbon gases with high global warming potential are to be avoided, when possible, in accordance with Federal Acquisition Regulations.

11-12 SMOKE DETECTION SYSTEMS

An approved smoke detection system is required in all areas of a facility where nuclear weapons are stored, inspected, or maintained in addition to the automatic suppression system. Also, smoke detection will be provided in the security control room complex (see Chapter 5), sleeping rooms, computer or information technology rooms, and in the vicinity of the fire alarm control panel (FACP), in addition to the automatic suppression system. An approved smoke detection system is not required in support areas (e.g., offices, mechanical spaces, corridors) where an automatic water-based fire suppression system has been provided (see paragraph 11-5). Appliances and other smoke detection equipment will be installed in accordance with NFPA 72 and UFC 3-600-01.

NOTE: An air-aspirating type of ultrasensitive smoke detection (i.e., very early smoke detection) or other smoke detection technology (e.g., open-area light-scattering smoke detection) should be used in areas designated as approved for the storage of nuclear weapons when EMRE requirements can be met (refer to Chapter 8).

11-13 FIRE ALARM SYSTEMS AND MASS NOTIFICATION SYSTEMS (MNS)

A combination system serving as the fire alarm system and MNS will be installed in accordance with UFC 3-600-01 and UFC 4-021-01.

11-13.1 Voice Communication

Means will be provided to allow a person observing a fire at any location in the facility to quickly and reliably alert the appropriate personnel using voice communication to the security control room or other suitable constantly attended location.

11-13.2 Signal Transmission

Signals will be transmitted to a constantly attended location from which required notifications and emergency response can be initiated. All signals must be permanently recorded in accordance with NFPA 72. These signals will include fire, trouble, and supervisory signals, and include at least the following:

- Actuation of any fire detection device
- Actuation of any fixed fire suppression system
- Actuation of any manual fire alarm station

- Starting of any fire pump
- Actuation of any supervisory device or signal
- Indication of alarm system trouble condition

11-13.3 Fire Department Notification

Means will be provided to promptly notify the fire department of any fire emergency in such a way as to allow the fire department to determine an appropriate course of action.

11-13.4 Security Forces Notification

Means will be provided to promptly notify the security forces of the nuclear weapons-capable maintenance and storage facility of any fire emergency in such a way as to allow the security forces to determine an appropriate course of action.

11-14 PORTABLE FIRE EXTINGUISHERS

See Chapter 5.

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CHAPTER 12 HEATING, VENTILATION, AND AIR CONDITIONING (HVAC)

NOTE: Cognizant Office of Responsibility for this chapter is AFCEC.

12-1 SCOPE

This chapter includes the criteria and requirements for HVAC applicable to nuclear weapons-capable maintenance and storage facilities.

12-2 DESIGN CONSIDERATIONS

12-2.1 Design of the System

HVAC systems for nuclear weapons-capable maintenance and storage facilities must be designed to meet the requirements of UFC 3-400-02, UFC 3-401-01, and UFC 3-410-01.

Suitable design of the ventilation system can limit the consequences of a fire by preventing the spread of the products of combustion to other fire areas. The design of the ventilation system must provide a means to ventilate, exhaust, or isolate the fire area as necessary, and consideration must be given to the consequences of failure of the ventilation system due to fire, causing loss of control for ventilating, exhausting, or isolating a given fire area.

12-2.1.1. The capability to ventilate, exhaust, or isolate is particularly important in underground nuclear weapons-capable maintenance and storage facilities to ensure the habitability of rooms and spaces that will remain occupied throughout the fire emergency (e.g., security control rooms). Areas of refuge also require particular attention since these are designated locations designed to help occupants survive for a specified period of time if they become trapped by a fire.

12-2.1.2. Automatic damper closure or shutdown of ventilation systems must be designed based on considerations of nuclear safety, nuclear security, and the life safety of personnel.

12-2.1.3. Facilities will be provided with 100 percent redundant chiller systems for those areas of the facility where lack of cooling could result in loss of human life or serious injuries, or result in serious mission or security issues.

12-2.1.4. In addition to the normal HVAC function, ventilation systems will also protect against chemical-biological (CB) agents when required by the Cognizant Offices of Responsibility.

12-2.2 Balanced Air Differentials

Ventilation of a nuclear weapons-capable storage facility involves balanced air differentials between building or blast zones, comfort ventilation, and heat removal from areas where heat is generated by equipment. This need for ventilation also includes fire

area isolation and smoke removal equipment, and may include equipment for high efficiency particulate air (HEPA) filtering of radioactive particulates.

12-2.3 Ventilation Design Standards

The design standards of the ventilation system will be in accordance with UFC 1-200-01.

12-2.4 Configuration

HVAC zones, fire areas (or zones), and blast zones (if used) should be arranged to coincide with each other (refer to Chapters 7 and 11).

12-3 INTERCONNECTIONS

Interconnections of individual fire areas via the ventilation system must be kept to a minimum. If an interconnection is made, it must be properly protected by fire stopping, fire and smoke dampers, and blast containment, as appropriate.

12-4 PORTABLE VENTILATION EQUIPMENT

In the event that fixed ventilation systems malfunction or are damaged and not capable of removing smoke and heat, portable ventilation equipment must be available. This equipment will be staged in the facility or be verified as readily available from the installation fire department. Sizing of the portable equipment and means to provide any required electrical power must be considered in the FHA and documented within the fire pre-plan.

12-5 HVAC INTAKE AND OUTLET LOCATIONS

HVAC intakes must be located and protected to prevent the accidental or intentional introduction of harmful gases or other materials.

Intakes and outlets for air-cleaning systems must be located to reduce the potential for the spread of radioactive contamination during maintenance.

12-6 FIRE, SMOKE, AND COMBINATION FIRE AND SMOKE DAMPERS

12-6.1 Fire Area Boundaries

Dampers will be provided at those fire area boundaries required to have a fire resistance rating of greater than 1 hour for both ventilation duct penetrations and air transfer openings. Where shutdown of the ventilation system is not permitted due to operational or security requirements, fire dampers will not be required for ventilation duct penetrations and an alternative means of protecting against fire propagation must be provided.

NOTE: This section is intended to address fire barriers within blast zones. Interconnections between blast zones are strongly discouraged.

NOTE: The need for automatic dampers and ventilation system shutdown can be minimized by installing separate ventilation systems for each fire area and blast zone or by installing fire-resistive ducting enclosures that provide the required fire barrier while passing through adjacent areas.

12-6.2 Fire Rating

Dampers having a rating of 1.5 hours must be installed where ventilation ducts penetrate fire barriers having a required fire resistance rating of 2 hours. Where ventilation ducts penetrate required 3-hour fire barriers, approved dampers having a fire protection rating of 3 hours must be installed.

12-6.3 Access

Access will be provided to ensure the damper can be properly and easily inspected, tested, and maintained, with particular consideration for the required periodic replacement of the damper's thermal elements.

12-6.4 Installation in Fire Barriers

Dampers will be installed directly into the fire barrier wall in accordance with the manufacturer's requirements. Dampers will be equipped with visible indicators to show damper position.

12-6.5 Listing

Dampers must be designed and installed in accordance with their listing and, where possible, installed in a configuration such that air movement in the duct assists in closing the damper.

12-7 FILTERS

12-7.1 Pre-filters

Air pre-filters located upstream or as part of the final HEPA filter exhaust plenums will be listed as Class 1 air filter units as tested in accordance with UL 900.

12-7.2 HEPA Filters

When used in nuclear ventilation exhaust systems, HEPA filters must meet the requirements for HEPA filters in ASME AG-1, Section FC, and be listed as a "high-efficiency, particulate, air filter unit" as tested in accordance with UL 586.

12-7.3 Self-Cleaning Filters

Self-cleaning filters are not permitted.

12-7.4 Spare Filters

At least a 100 percent supply of specialized spare filters, such as HEPA filters, will be maintained.

12-7.5 Noncombustible Materials

Roughing or pre-filters, where necessary, must be constructed of noncombustible materials.

12-7.6 Filter Framing Systems

Filter framing systems may be constructed of combustible material provided that the material has a flame spread rating of 25 or less and a smoke developed rating of 50 or less.

12-7.7 Filter Plenum Fire Separation

Filter plenums located inside nuclear weapons-capable buildings must be separated from all parts of the facility by 2-hour fire-rated construction.

12-7.8 Small Filter Plenums

Small filter plenums that serve as a final filter and have a leading surface area of 16 square feet (1.5 square meters) or less need not be separated by fire-rated construction from other parts of a facility or be located in a separate fire-rated enclosure if the filter plenum is located in an area provided with an automatic sprinkler system designed and installed in accordance with UFC 3-600-01.

12-7.9 Fire Suppression Systems

12-7.9.1 Fire suppression systems will be installed to protect filters that collect combustible material.

12-7.9.2 Where combustible filters, combustible particulates, or combustible ductwork (e.g., fiberglass-reinforced plastic) is present in the ventilation system, fire suppression systems must be provided. Additional fire protection features will be provided as appropriate for the fire hazard and the requirements documented in the FHA.

12-7.9.3 Fixed water spray systems must be provided for charcoal absorber beds containing more than 100 pounds (45.4 kilograms) of charcoal.

12-7.9.4 Automatic and manual water deluge spray systems will be provided inside all final filter plenums for protection of the filters where they have a leading filter surface area greater than 16 square feet (1.5 square meters).

12-7.9.5 Deluge spray sprinkler systems must operate upon activation of the fire alarm system heat detectors or pilot sprinklers located in either the final ducting or filter plenum housing. Manual activation will also be provided.

12-7.9.6 The design of the water deluge spray systems must reflect the potential for filter failure mechanisms, such as filter media damage resulting from weakened media due to water absorption and excessive differential pressures during water discharge.

NOTE: Such filter failure mechanisms can be significantly mitigated by throttling back fan controls to reduce filter pressure or by providing redundant filters.

12-7.9.7 Automatic deluge spray systems will be designed per the applicable provisions of NFPA 13 and NFPA 15, and as follows:

- Water spray density will be 0.25 gallon per minute per square foot (10.2 liters per minute per square meter) over the entire filter area or 1 gallon per minute (3.8 liters per minute) per 500 cubic feet per minute (14.2 cubic meters) of air flow, whichever is greater.
- Spray sprinklers must be of the deluge type.

12-7.9.8 The spray pattern of the deluge sprinklers must be in the form of a downward vertical water curtain approximately 6 inches (15 centimeters) in front of the pre-filter or demister. In addition, deluge sprinklers must be spaced so that each sprinkler does not exceed 4 lineal feet (1.2 lineal meters) of curtain coverage.

12-7.9.9 Manual spray systems must be designed per NFPA 15 with these specific requirements:

- Water spray density will be 0.25 gallon per minute per square foot (10.2 liters per minute per square meter) over the entire filter area.
- Nozzles will be deluge spray nozzles that form a full-circle, solid-cone discharge.
- Spray nozzles will be horizontally directed at the face of the first series of HEPA filters so all areas of the first stage filters and framing support system are wetted.
- Activation will be by activating the deluge valve or by opening a normally closed valve. Control devices to activate the manual spray system will be provided in the process operator's control room or other locations accessible to emergency response personnel. When a deluge valve is

used, manual activation may also be provided at the location of the deluge valve.

12-7.9.10 Water for the deluge spray systems must be provided by two separate water supply connections for reliability.

12-7.9.11 Automatic and manual water spray system water supplies will be hydraulically calculated. They must be capable of supplying a simultaneous flow of water for two hours to the automatic and manual water spray systems as well as the overhead ceiling automatic sprinkler systems in the fire area providing air to the HVAC plenum.

12-7.10 Demisters

12-7.10.1 Where automatic deluge spray systems are installed in filter plenum enclosures that do not contain pre-filters, metal demisters will be installed downstream of the automatic deluge spray sprinklers and upstream of the first series of HEPA filters.

Where automatic deluge spray systems are installed in the final filter plenum enclosures that contain pre-filters, water spray deluge sprinklers will be located upstream from the pre-filters.

NOTE: In this configuration, the pre-filters act as a demister.

Demisters must be located as far away as practical from HEPA filters but no closer than 36 inches (91 centimeters), and at approximately 6 inches (15 centimeters) from the deluge spray sprinklers.

12-7.10.2 Demisters will have an approximately 100 weight percent efficiency for water drops 50 microns and larger. They will have efficiency greater than 99 weight percent for 1 to 50 microns when air flow velocities are present of 500 to 600 feet per minute (150 to 185 meters per minute), or at operating air flow velocities with the deluge system operating water flow delivery rate.

12-7.11 Fire Screens

Fire screens must be located upstream from the pre-filters and final filter plenums. Fire screens with metal meshes from eight to sixteen openings per inch (three to six openings per square centimeter) will be provided and located at least 4 to 5 feet (1.2 to 1.5 meters) upstream from all pre-filters and at least 20 feet (6.1 meters) upstream from all final filter plenum enclosures. Where pre-filters are located in final filter enclosures, fire screens will be located at least 20 feet (6.1 meters) upstream from the pre-filters.

12-7.12 Heat Detection

Heat detectors or pilot sprinklers, when required to comply with paragraph 12-7.9, will be provided in ducting prior to final filter enclosures. Airflow must be considered when

determining detector or pilot sprinkler location. Heat detectors or pilot sprinklers will also be provided in the final filter enclosures. If filter plenum automatic deluge spray systems are actuated by pilot sprinklers, heat detectors are not required in the ducting or the final filter enclosure unless specified in the FHA.

12-7.13 Fire Alarm

The detection system or pilot sprinkler system will be arranged to detect a rise in airflow temperatures, actuate automatic fire suppression systems, and transmit an alarm to a constantly attended location (refer to paragraph 11-13.2). A pilot-operated system will be used only when an automatic water deluge spray system is installed.

12-7.14 Fire Detector Configuration for Testing

12-7.14.1 Fire detectors must be engineered and installed so they can be tested during the life of the detector. Easily removable panels will be provided to allow access for inspection and maintenance.

12-7.14.2 Where radiological contamination is not a concern, fire detectors may be installed such that the fire detector can be removed from the plenum enclosure and externally tested.

12-7.14.3 Remote testing must be provided for detectors that are not accessible due to facility configurations or personnel hazards.

12-7.14.4 If line-type heat detection is used, a heat testing pad will be provided outside of the plenum for operability testing of the system.

12-7.15 Lighting

Lighting must be provided inside the filter plenum in front of or between the filter banks in the area where the automatic and manual sprinklers and nozzles are located. Such lighting may be provided with an on-and-off switch, provided the switch is located outside the plenum at an accessible location.

12-7.16 Viewing Ports

Window viewing ports constructed of either wire glass, laminated lead safety glass, or fire-rated glass will be provided for viewing inside the filter plenum. The window viewing ports will be provided at each location where fire protection spray system sprinklers and nozzles are located and will be placed such that all sprinklers and nozzles are visible from the outside of the plenum to facilitate flow testing of the system.

12-8 DUCTWORK

Ductwork from areas containing radioactive materials that passes through nonradioactive areas must be of noncombustible construction and will be protected from possible exposure fires by materials having a fire resistance rating as approved by the

Cognizant Offices of Responsibility. For blast zones (see Chapter 7) this includes a requirement for hardened ductwork (i.e., steel piping).

Where the corrosive nature of the effluents conveyed precludes the use of metallic ducts, other materials will be permitted as approved by the Cognizant Offices of Responsibility.

12-9 SMOKE CONTROL

12-9.1 Where Required

Smoke control systems must be provided for facilities or portions of facilities classified as an “underground structure” or “limited access structure” as defined in NFPA 101.

12-9.2 Venting

Smoke, corrosive gases, and non-radioactive substances released by a fire will be vented from their place of origin directly to a location outside the facility where these substances will have the minimum potential to affect personnel outside of the facility.

12-9.3 Circulation

The smoke control system must be designed, located, and protected such that airborne corrosive products or contamination are not circulated (e.g., once-through ventilation systems).

12-9.4 Control of Radioactive Materials

Radioactive materials released by fire will be confined or removed and filtered from the exhaust ventilation airstream. Smoke exhaust from areas that contain radioactive substances must not be ventilated outside the building unless filtered through at least two stages of HEPA filters. Smoke control systems for such areas will be connected to treatment systems to preclude release of radioactive substances.

12-9.5 Release of Radioactive Material

The possible release to the environment of smoke containing radioactive materials must be monitored and modeled in accordance with emergency plans.

12-9.6 Fresh Air Inlets

Fresh air inlets will be located where contaminants are least likely to be present to reduce the potential of introducing smoke, toxic materials, or radioactive contaminants into the facility.

12-9.7 Enclosed Stairwells

Enclosed stairwells will be designed to minimize smoke infiltration during a fire via stairwell pressurization systems.

12-9.8 Natural Convection

Where natural convection ventilation is approved by the Cognizant Offices of Responsibility, the smoke and heat ventilation will provide a minimum ratio of vent area to floor area of at least 1 to 200, except in oil hazard areas, where at least a 1 to 100 ratio must be provided.

12-9.9 Firefighting

To facilitate manual firefighting, a method of operation of the smoke control systems must be provided for switchgear rooms, battery rooms, emergency power generation areas, fuel oil storage areas, and other areas where the potential exists for heavy smoke and heat conditions. The method of operation may be provided using local controls in the vicinity of the affected area or by remote controls under control of facility leadership.

12-10 LEAK TESTING

Open flame or combustion-generated smoke will not be used for leak testing.

12-11 POWER SUPPLIES AND CONTROLS

The power supply and controls for an HVAC system will be located outside the fire area served by the system. The security control room, facility control room, or other designated control location will be capable of remote monitoring and control of every ventilation system.

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CHAPTER 13 HOT WORK

NOTE: Cognizant Office of Responsibility for this chapter is AFSEC.

13-1 SCOPE

Hot work includes any temporary operation involving open flames or that produces heat or sparks, including brazing, cutting, grinding, soldering, arc welding, work on a pipe that would conduct heat through a wall or in contact with a wall, or torch-applied roofing. Non-powered (i.e., manual) cutting and grinding that do not generate sufficient heat or sparks to be considered a significant source of ignition to surrounding combustible materials do not require a permit.

13-2 PERMITS

Hot work must be coordinated and permitted through the appropriate local or base fire department.

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CHAPTER 14 UNDERGROUND FACILITIES

NOTE: Cognizant Office of Responsibility for this chapter is AFCEC.

14-1 SCOPE

This chapter includes requirements in addition to the requirements of Chapters 1 through 13 (unless otherwise specified) that are applicable to facilities where nuclear weapons-capable maintenance and storage areas are located underground.

14-2 ARCHITECTURAL REQUIREMENTS

Architectural requirements are provided in UFC 1-200-01.

14-2.1 Construction Type

Buildings will be constructed to be fire-resistant or noncombustible (Type I or Type II in accordance with the International Building Code [IBC]). All walls, floors, and structural components, except interior finish materials in office and support areas, will be of noncombustible construction. Use of combustible interior finishes must be minimized.

14-2.2 Hardened Fire Protection Systems

Buildings will be provided with hardened fire suppression systems in all areas and smoke detection systems (refer to Chapter 11 and Appendix B).

14-2.3 Fire Areas

NOTE: Cognizant Offices of Responsibility for this paragraph are AFCEC and AFSEC.

Facilities capable of storing nuclear weapons components will be subdivided into separate fire areas to minimize the risk of fire spread and the resultant consequential damage from fire gases, smoke, heat, radioactive contamination, and firefighting activities. In addition, the subdivision into fire areas must allow adequate access for manual fire suppression activities and be as consistent as possible with the blast zones.

14-2.3.1 Establishment of Boundaries

The boundaries of fire areas will be as established in the FHA based on general fire protection criteria that include these elements:

- Types, quantities, density, and locations of combustible materials and radioactive materials
- Location of blast doors and security access portals
- Location and configuration of equipment
- Consequences of inoperable equipment

- Location or zoning of fire detection and suppression systems
- Personnel safety, exiting, area of refuge requirement

14-2.3.2 Boundary Objectives

In underground facilities, fire area boundaries will accomplish fire protection objectives, including:

- To separate all contiguous buildings or portions thereof serving different purposes, such as storage, maintenance, service, administration, and other occupancy designations
- To separate weapons maintenance areas and weapons storage areas from each other and from adjacent areas
- To separate other types of maintenance areas from adjacent areas
- To separate security and other control rooms, computer rooms, and combined control and computer rooms from adjacent areas
- To separate rooms with major concentrations of electrical equipment, such as switchgear rooms and relay rooms, from adjacent areas
- To separate battery rooms from adjacent areas
- To separate each fire pump and its associated equipment from all other pumps in the same room or pump house
- To separate each fire pump from adjacent areas
- To separate warehouse areas and combustible storage areas from adjacent areas
- To separate standby or emergency power generators from each other and from adjacent areas
- To separate fan rooms and plenum chambers from adjacent areas
- To separate office areas from adjacent areas

14-2.3.3 Fire Barriers Separating Fire Areas

Fire barriers separating fire areas will have a minimum 3-hour fire resistance rating with listed 3-hour-rated penetration seals, and comply with the International Building Code.

14-2.3.4 Fire Doors and Fire Windows in Fire Barriers

Fire doors and fire windows used in fire barriers will be installed and maintained in accordance with NFPA 80. In the case of blast doors in fire barriers, refer to Chapter 7 of this document.

Typically, closed fire doors in fire barriers will be identified with a sign indicating, “Fire Door — Keep Closed.”

Windows in fire barriers, such as for a security control room or computer room, must be provided with a listed or approved fire shutter, automatic wall curtain, or fire resistance glazing.

14-2.4 Vertical Shafts and Plenums

To prevent the vertical spread of fire, all stairways, elevator shafts, escape ladders, and other vertical shafts and plenums must be enclosed with barriers having a fire resistance rating of at least 2 hours. Openings in such barriers must be protected with listed automatic or self-closing fire doors having a fire protection rating of at least 1.5 hours.

14-3 COMBUSTIBLE MATERIALS AND FINISHES

14-3.1 Weapons Storage Areas

Combustible materials must be excluded from fire areas designated for weapons storage, except for incidental amounts of combustible materials as determined by the FHA. Such incidental amounts might include solid wood blocks that serve as chocks for weapons support or small amounts of solvent used for weapons maintenance in the storage location.

14-3.2 Blast Shielding Materials

Permanent and temporary shielding materials will be noncombustible or limited combustible, based on:

- ASTM E84
- NFPA 253
- NFPA 255
- UL 94

Polystyrene used for sand walls is not required to be encased with fire-resistant materials.

14-3.3 Interior Finishes

14-3.3.1 Interior Wall and Ceiling Finish

Interior wall and ceiling finish in areas for processing or storing radioactive materials will be Class A in accordance with NFPA 255.

NOTE: The design should consider a potential radiation contamination incident and include wall and ceiling finishes that are easy to clean.

14-3.3.2 Interior Floor Finish

Interior floor finish in areas for processing or storing radioactive materials will be Class I in accordance with NFPA 253.

NOTE: The design should consider a potential radiation contamination incident and include floor finishes that are easy to clean.

14-3.4 Other Materials

Thermal insulation materials, radiation shielding materials, ventilation duct materials, soundproofing materials, and suspended ceilings, including light diffusers and their supports, will be noncombustible or limited combustible. If polypropylene or polyethylene is required for neutron shielding, it must be totally encased with a noncombustible material such as steel or 5/8-inch (16-millimeter) type X gypsum board. Approximately 3/8-inch (10-millimeter) vent holes must be provided within the encasement to permit the venting of gases from the poly material.

NOTE: Encasement is required because many plastic materials, including flame- and fire-retardant materials, will burn with an intensity and energy production in a range similar to that of ordinary hydrocarbons. When burning, they produce heavy smoke that obscures visibility and can plug air filters, especially charcoal and HEPA filters. When burning, halogenated plastics also release free chloride and hydrogen chloride. These gases are toxic to humans and corrosive to equipment.

14-4 HAZARD CONTROL

14-4.1 Flammable and Combustible Liquids

14-4.1.1 Where oil-burning equipment, stationary combustion engines, or gas turbines are used, they will be installed and used in accordance with NFPA 31 or NFPA 37, as appropriate.

14-4.1.2 Flammable and combustible liquid and gas piping will be in accordance with ASME B31.1 or the ASME *Boiler and Pressure Vessel Code*, Section III, as applicable.

14-4.2 Hydraulic Systems

Hydraulic systems will use only listed fire-resistant hydraulic fluids.

14-4.3 Solvents

Where a flammable or combustible solvent is used, it must be handled such that the uncontrolled release of vapors is not permitted.

14-4.4 Gases

Flammable and combustible gases will be stored and handled in accordance with NFPA 54, NFPA 55, and NFPA 58.

Bulk flammable gas storage, either compressed or cryogenic, will not be permitted inside structures capable of storing nuclear weapons.

Storage of flammable gas, such as hydrogen, will be located outdoors or in separate detached buildings so a fire or explosion will not adversely affect any nuclear weapons storage facility systems or equipment.

14-5 LIQUID RUN-OFF CONTROL

Drainage will be provided in all areas of the facility for the removal of all liquids directly to safe areas, or for containment in the area without adverse flooding of equipment and without endangering other areas.

14-5.1 Methods

Drainage and the prevention of equipment water damage will be accomplished by one or more of these methods:

- Floor drains
- Floor trenches
- Open doorways or other wall openings
- Curbs for containing or directing drainage
- Equipment pedestals
- Pits, sumps, and sump pumps

14-5.2 Sump Pump Systems

Waste and drainage sump pump systems must be provided with 100 percent redundant pumps.

14-5.3 Drainage and Drainage Facility Size

Drainage and any associated drainage facilities for a given area will be sized to accommodate the volume of liquid produced by all of these sources:

- The spill of the largest single container of any flammable or combustible liquids in the area.
- The credible volume of discharge (as determined by the FHA) released by the automatic suppression system operating for a period of 30 minutes

unless the approved FHA authorizes use of a different flow rate and duration.

- The contents of piping systems and containers that could fail in a fire.
- The volume of water discharged based on a manual firefighting flow rate of 500 gallons per minute (1,890 liters per minute) for 30 minutes unless the approved FHA authorizes use of a different flow rate and duration.
- For areas open to the outside, such as underground loading docks, credible environmental factors such as rain and snow.

14-5.4 Staging Equipment

Necessary equipment must be staged to assist with routing water from the affected area. The use of the staging equipment will be addressed in the fire department pre-fire plan.

14-5.5 Floor Drainage

Floor drainage from areas containing flammable or combustible liquids will be trapped to prevent the spread of burning liquids beyond the fire area.

14-5.5.1 Areas with Radioactive Materials

Floor drainage from areas containing nuclear weapons components must be trapped to prevent the spread of radioactive materials beyond the facility's controlled boundaries. If the drainage system leads to tanks, the tanks will be designed to be criticality safe.

Water drainage from areas that might contain radioactivity must be collected, sampled, and analyzed before discharge to the environment or outside the boundaries of the facility.

Water released during fire suppression operations in areas containing radioactivity will be drained to a location that would be acceptable for the containment of radioactive materials.

14-5.5.2 Facilities with Gaseous Fire Suppression Systems

Where gaseous fire suppression systems are installed, floor drains will be provided with adequate seals or the fire suppression system will be sized to compensate for the loss of the gaseous fire suppression agent through the drains.

14-6 THROUGH PENETRATION FIRE STOPS

14-6.1 Where Required

Fire stops for penetrations such as pipes, conduits, bus ducts, cables, wires, pneumatic tubes and ducts, and similar building service equipment that passes through fire barriers

will be provided to prevent the spread of fire using listed or approved materials (caulking) or devices (sleeves).

If the fire barriers coincide with or are also serving as a blast-resistant barrier, these penetrations will also require blast-resistant devices. If the blast-resistant device is sufficient to serve as protection from the spread of fire, no additional protection is necessary. If the blast-resistant penetration device is not listed or approved for fire penetrations, it can be evaluated by a qualified fire protection engineer and accepted as a fire barrier product by the Cognizant Office of Responsibility.

14-6.2 Annular Spaces

The annular space between the penetrating item and the through opening in the fire barrier must be filled with a qualified (listed or approved) fire-resistive penetration seal assembly capable of maintaining the fire resistance of the fire barrier. The assembly will be qualified by tests in accordance with fire test protocols or be protected by a listed fire-rated device for the specified fire-resistive period. Penetration seals provided for electrical and mechanical openings will be listed as meeting the requirements of ASTM E814 or UL 1479.

14-6.3 Conduit Seals

Refer to Chapter 3.

14-6.4 Leak Testing

Open flame- or combustion-generated smoke must not be used for leak testing.

14-7 COMMUNICATIONS

Communication systems using a commonly described “lossy” antenna distribution system within the facility will be limited as much as possible and will be within the allowable electromagnetic radiation (EMR) limits of the applicable STS.

All electrical equipment and devices are either intentional or unintentional EMR emitters as defined in Chapter 8. All such equipment to be used in close proximity to critical equipment interior to the facility must not exceed the allowable EMR limits of the applicable STS. Anticipated EMR emitters will be analyzed to evaluate anticipated EMRE levels. If the EMRE levels exceed allowable limits, facility design, equipment selection, or procedures must be adjusted to mitigate EMRE levels.

14-8 LIFE SAFETY AND MEANS OF EGRESS

NOTE: Cognizant Offices of Responsibility for this paragraph are AFCEC and AFSEC.

14-8.1 Life Safety Performance Criteria

The following performance criteria will be met during all operational modes and plant configurations:

- Provide safe egress or areas of refuge for all occupants of the facility.
- Provide adequate protection, including emergency lighting and communication, for essential personnel to perform necessary weapons safety and security functions in case of a fire event.
- Provide adequate protection (e.g., self-contained breathing apparatus [SCBA] units, supplied air connections) for other facility personnel designated to provide emergency response services during or following a fire.

14-8.2 Occupancy Classification

14-8.2.1 Storage

Those areas involved in the storage of nuclear weapons will be considered special-purpose industrial occupancies and as underground spaces as defined in NFPA 101.

Warehouses and storage areas designated for the storage of materials other than nuclear weapons will conform to the ordinary hazard storage occupancy (refer to Chapters 6 and 42 of NFPA 101) and underground space requirements in NFPA 101.

14-8.2.2 Maintenance

Those areas involved in the maintenance of nuclear weapons will be considered special-purpose industrial occupancies and as underground spaces as defined in NFPA 101.

14-8.2.3 Other Areas

General office areas, break rooms, security control rooms, office buildings, and training facilities will conform to the business occupancy and underground space requirements in NFPA 101.

14-8.3 Occupant Load

In determining the exiting requirements for a nuclear weapons-capable maintenance and storage facility, the actual number of assigned personnel and expected number of visitors during operations, maintenance, and testing, with an added safety factor of 20 percent, will be used to determine the occupant load in lieu of other criteria within NFPA 101.

14-8.4 Number of Means of Egress

Fire areas will have at least one means of egress for those facilities protected throughout by an automatic fire suppression system. When nuclear security requirements prohibit the use of approved egress components (such as a listed fire door meeting the requirements of NFPA 101) for the means of egress, an area of refuge must also be provided within the fire area (refer to paragraph 14-9.6).

Two means of egress out of the fire area will be provided for facilities not protected throughout by a fire suppression system. One of these means of egress may be an area of refuge. When nuclear security requirements prohibit the use of approved egress components (such as a listed fire door meeting the requirements of NFPA 101) for the means of egress, an area of refuge must be provided within the fire area (refer to paragraph 14-9.6).

14-8.5 Horizontal Exit

A horizontal exit will be considered to be any adjacent fire area separated by at least 3-hour fire-rated construction and accessible through listed fire doors meeting the requirements of NFPA 101 and NFPA 80.

14-8.6 Area of Refuge

An area of refuge must:

- Be separated from adjacent areas by at least 3-hour fire-rated construction
- Minimize the entrance of smoke
- Be protected throughout by automatic sprinklers
- Be provided with two-way communication (including instructions on the operation of the equipment)

Areas of refuge must be provided with protective heat-resistant clothing, emergency drinking water, and sufficient breathing air to permit survival for at least 72 hours based on the expected occupant load. The occupant capacity for the area of refuge will be established in the FHA.

NOTE: When possible, the area of refuge within a fire area should be located near the nuclear security access doors into the fire area.

14-8.7 Travel Distances

14-8.7.1 Weapon Storage Areas

For weapon storage areas, travel distances to an exterior exit, horizontal exit, or area of refuge within the fire area will not exceed 400 feet (122 meters) for facilities protected throughout by an automatic fire suppression system. For facilities not protected

throughout by an automatic fire suppression system, these travel distances will not exceed 200 feet (61 meters).

14-8.7.2 All Other Areas

For all other areas, travel distances to an exterior exit, horizontal exit, or area of refuge within the fire area will not exceed 300 feet (91 meters) for facilities protected throughout by an automatic fire suppression system. For facilities not protected throughout by an automatic fire suppression system, these travel distances will not exceed 200 feet (61 meters).

14-8.8 Common Path of Travel

14-8.8.1 Weapon Storage Areas

For weapon storage areas, common path of travel distances are not limited, provided the areas are protected with an automatic fire suppression system. For facilities not protected throughout by an automatic fire suppression system, common path of travel must not exceed 75 feet (23 meters).

14-8.8.2 All Other Areas

For all other areas, common path of travel must not exceed 100 feet (30 meters) for facilities protected throughout by an automatic fire suppression system. For facilities not protected throughout by an automatic fire suppression system, common path of travel must not exceed 75 feet (23 meters).

14-8.9 Dead-End Corridors

14-8.9.1 Weapon Storage Areas

For weapon storage areas, dead-end corridor distances are not limited, provided travel distances and common path of travel distances are not exceeded (see paragraphs 14-9.7 and 14-9.8).

14-8.9.2 All Other Areas

For all other areas, dead-end corridors must not exceed 50 feet (15 meters) for facilities protected throughout by an automatic fire suppression system. For facilities not protected throughout by an automatic fire suppression system, dead-end corridors must not exceed 20 feet (6.1 meters).

14-8.10 Special Locking Devices

Special locking devices (e.g., dead bolts and slide bolts) may be installed and left engaged on exit doors during periods of occupancy in addition to the normal door locking devices, provided the devices are required by security, are clearly visible to the building occupants, and the building occupants are advised of their presence.

NOTE: Such locking devices should be marked or painted with a bright contrasting color (e.g., orange, yellow, red) to be clearly visible to the occupants.

14-9 FIRE HYDRANTS IN VEHICLE LOADING TUNNELS

Hydrants will be installed within approximately 50 feet (15 meters) of each end of each vehicle loading tunnel provided for the underground structures.

14-10 SECURITY CONTROL ROOM COMPLEX

See Chapter 5 for security control room complex requirements.

14-11 COMMUNICATIONS

For all communication systems that are wireless or EMR-emitting devices, the restrictions of Chapter 8 will be implemented, as appropriate.

Prior to the introduction of wireless devices, the devices must be reviewed by the Host Wing, Weapons Safety Office.

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CHAPTER 15 INDUSTRIAL FACILITIES

NOTE: Cognizant Office of Responsibility for this chapter is AFCEC.

15-1 SCOPE

This chapter includes requirements in addition to the requirements (unless otherwise specified) of Chapters 1 through 13 that are applicable to ground-level industrial facilities where nuclear weapons-capable activities such as inspection, testing, and maintenance take place, but not storage. For restricted access/egress, ground-level facilities where inspection, testing, maintenance, and storage takes place will comply with Chapter 17 in lieu of this chapter. For underground facilities, comply with Chapter 14 in lieu of this chapter.

15-2 ARCHITECTURAL REQUIREMENTS

Architectural requirements are provided in UFC 1-200-01.

15-2.1 Construction Type

Buildings will be constructed to be fire-resistant or noncombustible (Type I or Type II in accordance with the IBC). All walls, floors, and structural components, except interior finish materials in office and support areas, will be of noncombustible construction. Use of combustible interior finishes will be minimized.

15-2.2 Hardened Fire Protection Systems

Buildings will be provided with hardened fire suppression systems in all areas and smoke detection systems (refer to Chapter 11 and Appendix B).

15-2.3 Fire Areas

Facilities capable of inspecting, maintaining, or storing nuclear weapons components must be subdivided into separate fire areas to minimize the risk of fire spread and the resultant consequential damage from fire gases, smoke, heat, radioactive contamination, and firefighting activities. In addition, the subdivision into fire areas will allow adequate access for manual fire suppression activities and be as consistent as possible with the blast zones.

15-2.3.1 Establishment of Boundaries

The boundaries of fire areas will be established in the FHA based on general fire protection criteria that include these elements:

- Types, quantities, density, and locations of combustible materials and radioactive materials
- Location of blast doors and security access portals

- Location and configuration of equipment
- Consequences of inoperable equipment
- Location or zoning of fire detection and suppression systems
- Personnel safety, exiting, and area of refuge requirements
- Building separations and occupancy separation requirements

15-2.3.2 Boundary Objectives

In industrial facilities, fire area boundaries will accomplish fire protection objectives, including:

- To separate all contiguous buildings or portions thereof serving different purposes, such as storage of combustible materials, maintenance, service, administration, and other occupancy designations
- To separate weapons maintenance areas from adjacent areas
- To separate fueling areas from adjacent areas
- To separate security and other control rooms, computer rooms, or combined control and computer rooms from adjacent areas
- To separate rooms with major concentrations of electrical equipment, such as switchgear rooms and relay rooms, from adjacent areas
- To separate battery rooms from adjacent areas
- To separate each fire pump and its associated equipment from all other pumps in the same room or pump house
- To separate each fire pump from adjacent areas
- To separate warehouse areas and combustible storage areas from adjacent areas
- To separate standby or emergency power generators from each other and from adjacent areas
- To separate fan rooms and plenum chambers from adjacent areas
- To separate office areas from adjacent areas

15-2.3.3 Fire Barriers Separating Fire Areas

Fire barriers separating fire areas must have a minimum 2-hour fire resistance rating with listed 2-hour-rated penetration seals.

15-2.3.4 Fire Doors and Fire Windows in Fire Barriers

Fire doors and fire windows in fire barriers will be installed and maintained in accordance with NFPA 80. In the case of blast doors in fire barriers, refer to paragraph 7-4.3.8 of this document.

Typically, closed fire doors in fire barriers will be identified with a sign indicating, “Fire Door — Keep Closed.”

Windows in fire barriers, such as for a security control room or computer room, must be provided with a listed or approved fire shutter, automatic wall curtain, or fire resistance glazing.

15-2.4 Vertical Shafts and Plenums

To prevent vertical spread of fire, all stairways, elevator shafts, escape ladders, and other vertical shafts and plenums will be enclosed with barriers having a fire resistance rating of at least 2 hours. Openings in such barriers must be protected with listed automatic or self-closing fire doors having a fire protection rating of at least 1.5 hours.

15-3 COMBUSTIBLE MATERIALS AND FINISHES

15-3.1 Blast Shielding Materials

Permanent and temporary shielding materials will be noncombustible or limited combustible, based on:

- ASTM E84
- NFPA 253
- NFPA 255
- UL 94

Polystyrene used for sand walls is not required to be encased with fire-resistant materials.

15-3.2 Interior Finishes

15-3.2.1 Interior Wall and Ceiling Finish

Interior wall and ceiling finish in areas processing or storing radioactive materials must be Class A in accordance with NFPA 255.

NOTE: The design should consider a potential radiation contamination incident and include wall and ceiling finishes that are easy to clean.

15-3.2.2 Interior Floor Finish

Interior floor finish in areas processing or storing radioactive materials will be Class I in accordance with NFPA 253. If required to meet weapon maintenance environmental conditions, anti-static flooring having less than a Class I fire rating is permitted when approved by the Cognizant Office of Responsibility.

NOTE: The design should consider a potential radiation contamination incident and include floor finishes that are easy to clean.

15-3.3 Other Materials

Thermal insulation materials, radiation shielding materials, ventilation duct materials, soundproofing materials, and suspended ceilings, including light diffusers and their supports, must be noncombustible or limited combustible. If polypropylene or polyethylene is required for neutron shielding, it must be totally encased with a noncombustible material such as steel or 5/8-inch (16-millimeter) type X gypsum board. Approximately 3/8-inch (10-millimeter) vent holes must be provided within the encasement to permit the venting of gases from the poly material.

NOTE: Encasement is required because many plastic materials, including flame- and fire-retardant materials, will burn with an intensity and energy production in a range similar to that of ordinary hydrocarbons. When burning, these materials produce heavy smoke that obscures visibility and can plug air filters, especially charcoal and HEPA filters. When burning, halogenated plastics also release free chloride and hydrogen chloride. These gases are toxic to humans and corrosive to equipment.

15-4 HAZARD CONTROL

15-4.1 Flammable and Combustible Liquids

15-4.1.1 Where oil-burning equipment, stationary combustion engines, or gas turbines are used, they will be installed and used in accordance with NFPA 31 or NFPA 37, as appropriate.

15-4.1.2 Flammable and combustible liquid and gas piping will be in accordance with ASME B31.1 or the ASME *Boiler and Pressure Vessel Code*, Section III, as applicable.

15-4.2 Hydraulic Systems

Hydraulic systems must use only listed fire-resistant hydraulic fluids. Such fluids will be approved by the Factory Mutual Research Corporation or the Mine Safety and Health Administration.

15-4.3 Solvents

Where a flammable or combustible solvent is used, it will be handled such that the uncontrolled release of vapors is not permitted.

15-4.4 Gases

Flammable and combustible gases will be stored and handled in accordance with NFPA 54, NFPA 55, and NFPA 58.

Bulk flammable gas storage, either compressed or cryogenic, will not be permitted inside structures capable of maintaining nuclear weapons.

Storage of flammable gas, such as hydrogen, will be located outdoors or in separate detached buildings so that a fire or explosion will not adversely affect any nuclear weapons maintenance facility systems or equipment.

15-5 REFUELING AREAS

15-5.1 Automatic Fire Suppression

Automatic foam fire suppression systems will protect the area from the hazards defined within the FHA and be designed in accordance with NFPA 11.

15-5.2 Electrical Equipment

Electrical equipment will comply with NFPA 70, including Chapter 5, “Special Occupancies,” and other NFPA 70 requirements related to hazardous locations.

15-5.3 Fuel Transfer Pumps

Where pumps are used for liquid fuel transfer, means will be provided to shut down liquid transfer in the event of a spill or fire.

15-5.4 Fuel Storage Tanks

Fuel storage (i.e., day tanks) located within refueling areas must not exceed 200 gallons (757 liters).

Fuel storage tanks will be equipped with overfill protection.

15-5.5 Fuel Line Shutoff

Fuel supply lines entering refueling areas must be arranged with a spring-loaded automatic shutoff valve that is activated via a fusible link.

15-5.6 Curbing in Refueling Areas

Refueling areas must be provided with curbing designed to capture the entire contents of the fuel within the facility and the discharge of the fire suppression system for 30 minutes.

15-5.7 Ventilation

15-5.7.1 Refueling Areas

Refueling areas will be provided with either a gravity system or a continuous mechanical exhaust ventilation system.

15-5.7.2 Exhaust Location

Exhaust air must be taken from a point near a wall on one side of the room and within 12 inches (30.5 centimeters) of the floor, with one or more make-up inlets located on the opposite side of the room within 12 inches (30.5 centimeters) of the floor.

15-5.7.3 Air Openings

The location of both the exhaust and inlet air openings must be arranged to provide air movement across all portions of the floor to prevent the accumulation of vapors.

15-5.7.4 Recirculation

Exhaust from the room must be conducted directly to the exterior of the building and must not be recirculated.

15-5.7.5 Ducts

If ducts are used, they must not be used for any other purpose and will comply with NFPA 91.

15-5.7.6 Make-Up Air

If make-up air to a mechanical system is taken from within the building, the opening will be equipped with a fire door or damper as required in NFPA 91.

15-5.7.7 Gravity Systems

For gravity systems, the make-up air must be supplied from outside of the building.

15-5.7.8 Capacity

Mechanical ventilation systems must provide at least 1 cubic foot per minute (28.3 liters per minute) of exhaust air for each square foot (0.09 square meter) of floor area, but not less than 150 cubic feet per minute (4,248 liters per minute).

15-5.7.9 Dispensing Areas

The mechanical ventilation system for dispensing areas must be equipped with an airflow switch or other equally reliable method that is interlocked to sound an audible alarm upon failure of the ventilation system.

15-5.7.10 Air Intake Height

The minimum height of air intakes in these areas must be in accordance with UFC 4-010-01.

15-5.8 Static Electricity

Means must be provided to minimize the generation of static electricity in the refueling area. See AFI 91-203, NFPA 77, and NFPA 407.

15-6 LIQUID RUN-OFF CONTROL

NOTE: Cognizant Offices of Responsibility for this paragraph are AFCEC and AFSEC.

Drainage will be provided in all areas of the facility for the removal of all liquids directly to safe areas, or for containment in the area without adverse flooding of equipment and without endangering other areas.

15-6.1 Methods

Drainage and the prevention of equipment water damage will be accomplished by one or more of these methods:

- Floor drains
- Floor trenches
- Open doorways or other wall openings
- Curbs for containing or directing drainage
- Equipment pedestals
- Pits, sumps, and sump pumps

15-6.2 Sump Pump Systems

Waste and drainage sump pump systems must be provided with 100 percent redundant pumps.

15-6.3 Drainage and Drainage Facility Size

Drainage and any associated drainage facilities for a given area will be sized to accommodate the volume of liquid produced by all of these sources:

- The spill of the largest single container of any flammable or combustible liquids in the area
- The credible volume of discharge (as determined by the FHA) released by the automatic suppression system operating for a period of 30 minutes, unless the approved FHA authorizes a different flow rate and duration
- The contents of piping systems and containers that could fail in a fire
- The volume of water discharged based on a manual firefighting flow rate of 500 gallons per minute (1,890 liters per minute) for 30 minutes unless the approved FHA authorizes a different flow rate and duration
- For areas open to the outside, such as underground loading docks, credible environmental factors such as rain and snow

15-6.4 Staging Equipment

Necessary equipment must be staged to assist with routing water from the affected area. The use of the staging equipment will be addressed in the fire department pre-fire plan.

15-6.5 Floor Drainage

Floor drainage from areas containing flammable or combustible liquids must be trapped to prevent the spread of burning liquids beyond the fire area.

15-6.5.1 Areas with Radioactive Materials

Floor drainage from areas containing nuclear weapons components must be trapped to prevent the spread of radioactive materials beyond the facility's controlled boundaries. If the drainage system leads to tanks, the tanks will be designed to be criticality safe.

Water drainage from areas that might contain radioactivity must be collected, sampled, and analyzed before discharge to the environment or outside the boundaries of the facility.

Water released during fire suppression operations in areas containing radioactivity must be drained to a location that would be acceptable for the containment of radioactive materials.

15-6.5.2 Facilities with Gaseous Fire Suppression Systems

Where gaseous fire suppression systems are installed, floor drains must be provided with adequate seals or the fire suppression system will be sized to compensate for the loss of the gaseous fire suppression agent through the drains.

15-7 THROUGH PENETRATION FIRE STOPS

15-7.1 Where Required

15-7.1.1 Penetrations

Fire stops for penetrations such as pipes, conduits, bus ducts, cables, wires, pneumatic tubes and ducts, and similar building service equipment that passes through fire barriers will be provided to prevent the spread of fire using listed or approved materials (caulking) or devices (sleeves).

15-7.1.2 Blast-Resistant Barrier

If the fire barriers coincide with or are also serving as a blast-resistant barrier, these penetrations will also require blast-resistant devices. If the blast-resistant device is sufficient to serve as protection from the spread of fire, no additional protection is necessary. If the blast-resistant penetration device is not listed or approved for fire penetrations, it can be evaluated by a qualified fire protection engineer and accepted as a fire barrier product by the Cognizant Office of Responsibility.

15-7.2 Annular Spaces

The annular space between the penetrating item and the through opening in the fire barrier will be filled with a qualified (listed or approved) fire-resistive penetration seal assembly capable of maintaining the fire resistance of the fire barrier. The assembly must be qualified by tests in accordance with fire test protocols or be protected by a listed fire-rated device for the specified fire-resistive period. Penetration seals provided for electrical and mechanical openings will be listed as meeting the requirements of ASTM E814 or UL 1479.

15-7.3 Conduit Seals

Refer to Chapter 3.

15-7.4 Leak Testing

Open flame- or combustion-generated smoke must not be used for leak testing.

15-8 COMMUNICATIONS

NOTE: Cognizant Office of Responsibility for this paragraph is AFSEC.

Communication systems using a lossy antenna distribution system within the facility will be limited as much as possible and will be within the allowable EMR limits of the STS.

All electrical equipment and devices are either intentional or unintentional EMR emitters and must be evaluated as discussed in Chapter 8. All such equipment to be used in close proximity to critical equipment interior to the facility must not exceed the

allowable EMR limits of the STS. Anticipated EMR emitters will be analyzed to evaluate anticipated EMRE levels. If the EMRE levels exceed allowable limits, facility design, equipment selection, or procedures must be adjusted to mitigate EMRE levels.

15-9 LIFE SAFETY AND MEANS OF EGRESS

NOTE: Cognizant Offices of Responsibility for this paragraph are AFCEC and AFSEC.

15-9.1 Life Safety Performance Criteria

The following performance criteria must be met during all operational modes and plant configurations:

- Provide safe egress or areas of refuge for all occupants of the facility.
- Provide adequate protection, including emergency lighting and communication, for essential personnel to perform necessary weapons safety and security functions in case of a fire event.
- Provide adequate protection (e.g., SCBA units, supplied air connections) for other facility personnel designated to provide emergency response services during or following a fire.

15-9.2 Occupancy Classification

Industrial facilities involved in the inspection, testing, and maintenance of nuclear weapons will be considered special purpose industrial occupancies as defined in NFPA 101.

General office areas, break rooms, security control rooms, office buildings, and training facilities will conform to the business occupancy requirements in NFPA 101.

Warehouses and storage areas designated for the storage of materials other than nuclear weapons will conform to the ordinary hazard storage occupancy requirements in NFPA 101 (refer to Chapters 6 and 42 of NFPA 101).

15-9.3 Occupant Load

In determining the exiting requirements for a nuclear weapons-capable maintenance and storage facility, the actual number of assigned personnel and expected number of visitors during operations, maintenance, and testing with an added safety factor of 30 percent will be used to determine occupant load in lieu of other criteria within NFPA 101.

15-9.4 Number of Means of Egress

15-9.4.1 Two Means of Egress

Fire areas must have at least two means of egress, including those facilities protected throughout by an automatic fire suppression system.

15-9.4.2 Single Means of Egress

A single means of egress will be permitted from any story or section of an industrial facility, provided that the exit can be reached within 100 feet (30 meters) for a sprinklered facility (50 feet [15 meters] for a nonsprinklered facility) and when the single means of egress is approved by the Cognizant Offices of Responsibility.

15-9.4.3 Refueling Areas

Refueling areas must have not less than two means of egress, one of which must include an exit directly to the exterior of the facility.

15-9.4.4 Area of Refuge

When nuclear security requirements prohibit the use of approved egress components (such as a listed fire door meeting the requirements of NFPA 101) in the means of egress, an area of refuge must be provided within the fire area (refer to paragraph 15-10.6.

15-9.5 Horizontal Exit

A horizontal exit will be considered to be any adjacent fire area separated by at least 2-hour fire-rated construction and accessible through listed fire doors meeting the requirements of NFPA 101 and NFPA 80.

15-9.6 Area of Refuge

An area of refuge will:

- Be separated from adjacent areas by at least 3-hour fire-rated construction
- Minimize the entrance of smoke
- Be protected throughout by automatic sprinklers
- Be provided with two-way communication (including instructions on the operation of the equipment)

An area of refuge will be provided with protective heat-resistant clothing, emergency drinking water, and sufficient breathing air to permit survival for at least 72 hours based on the expected occupant load. The occupant capacity for the area of refuge will be established in the FHA.

NOTE: When possible, the area of refuge within a fire area should be located near the nuclear security access doors into the fire area.

15-9.7 Travel Distances

Travel distances to an exterior exit, horizontal exit, or area of refuge within the fire area must not exceed 400 feet (122 meters) for facilities protected throughout by an automatic fire suppression system. For facilities not protected throughout by an automatic fire suppression system, travel distances to an exterior exit, horizontal exit, or area of refuge within the fire area must not exceed 200 feet (61 meters).

For refueling areas, travel distances to an exterior exit must not exceed 75 feet (23 meters).

15-9.8 Common Path of Travel

The common path of travel must not exceed 100 feet (30 meters) for facilities protected throughout by an automatic fire suppression system. For facilities not protected throughout by an automatic fire suppression system, the common path of travel must not exceed 75 feet (23 meters).

15-9.9 Dead-End Corridors

Dead-end corridors must not exceed 50 feet (15 meters) for facilities protected throughout by an automatic fire suppression system. For facilities not protected throughout by an automatic fire suppression system, dead-end corridors must not exceed 20 feet (6.1 meters).

15-9.10 Special Locking Devices

Special locking devices (such as dead bolts and slide bolts) may be installed and left engaged on exit doors during periods of occupancy in addition to the normal door locking devices, provided the devices are required by security, are clearly visible to the building occupants, and the building occupants are advised of their presence.

NOTE: Such locking devices should be marked or painted with a bright contrasting color (e.g., orange, yellow, red) to be clearly visible to the occupants.

15-10 SECURITY CONTROL ROOM COMPLEX

See Chapter 5 for security control room complex requirements.

15-11 COMMUNICATIONS

For all communication systems that are wireless or EMR emitting devices, the restrictions in Chapter 8 must be considered and implemented as appropriate.

Prior to the introduction of wireless devices, the devices must be reviewed by the Host Wing, Weapons Safety Office.

15-12 ELECTROEXPLOSIVE DEVICES (EED)

NOTE: Cognizant Offices of Responsibility for this paragraph are AFCEC and AFSEC.

15-12.1 Storage and Testing Area Criteria

Areas where EEDs are stored or tested will meet the following criteria:

15-12.1.1 Separation

EED areas must be separated from the remainder of the industrial facility by not less than 3-hour-rated walls.

15-12.1.2 Seals

All permanent penetrations into and out of the room will be sealed by a listed or approved means (i.e., penetration seals, fire and smoke dampers).

Penetrations provided for use in remote testing or remote electrical testing may be covered with a movable steel door or “flap” that is configured with a small slit that allows temporary wiring needed for the testing to penetrate the wall.

15-12.1.3 Ventilation Ductwork

Ventilation ductwork that penetrates the room must be equipped with fire or combination fire and smoke dampers with at least a 3-hour fire rating. Alternate means of protection of the ductwork (i.e., without dampers) are not permitted.

15-12.1.4 Blast Doors

Blast doors into the rooms will be evaluated by a qualified fire protection engineer to determine if the door may be considered as equivalent to that of a 3-hour-rated fire door. Use of blast doors for this purpose must be approved by the Cognizant Offices of Responsibility.

15-12.1.5 Fire Suppression

The room must be protected by an automatic sprinkler fire suppression system.

NOTE: The sprinklers should be supplied from above the ceiling and also provided with sprinkler guards. These features will help reduce damage to the sprinkler system due to explosion.

15-12.1.6 Grounding

Grounding or bonding to an earth ground will be provided (refer to Chapter 3).

15-12.2 Deflagration Venting

Areas where EEDs are stored or tested must be provided with deflagration venting in accordance with NFPA 68. The following features will be provided:

NOTE: According to the NFPA *Fire Protection Handbook*, industry experience shows that detonations cannot be adequately vented; however, deflagration venting should still be provided as a best management practice.

15-12.2.1 Exterior Wall

The vent area will be located in an exterior wall.

15-12.2.2 Symmetry

The vent area will be distributed symmetrically and evenly on the external wall.

15-12.2.3 Vent Closures

The types of building vent closures permitted include:

- Hinged doors
- Windows and panel closures that swing in the outward direction and have latches or similar hardware that automatically release under calculated release pressure
- Friction, spring-loaded, or magnetic latches of the type used for doors on industrial ovens

15-12.2.4 Fasteners

Shear and pull-through fasteners are permitted to be used where the vent design requires large areas, such as the entire wall of an EED room.

15-12.2.5 Restraints

The means of restraining large panels will be documented in the FHA.

15-12.2.6 Restriction of Vent Area

No restraint for any vent closure will result in restricting the vent area.

15-12.2.7 Total Mass of Closure

Any hardware added to a vent closure will be included when determining the total mass of the closure.

15-12.2.8 Hinges

Hinged doors or covers will be permitted to be designed to function as vent closures. The hinge must be designed to ensure the closure device remains intact during venting.

15-12.3 Inspection

Explosive venting systems will be inspected annually and the inspection will include at least these system conditions:

- The opening is clear of obstructions on both sides.
- The exhaust from the opening does not discharge to an occupied area.
- Changes made to the venting system installation since the last inspection.
- The venting system is not corroded or otherwise damaged.
- The explosive venting configuration is clearly identified.
- The explosive venting configuration is not damaged and will not be obstructed by snow, ice, insects, animals, plant growth, or other environmental conditions.
- The explosive venting device will not be impeded in its operation.

15-13 ARMORIES

15-13.1.1 Fire Rating

Armories will be separated from the remainder of the facility by a minimum of 2-hour fire-rated walls and 1.5-hour-rated fire doors.

15-13.1.2 Fire Stops

Penetrations into armories must be fire stopped (e.g., fire dampers, penetration seals) in addition to security requirements.

15-13.1.3 Automatic Sprinklers

Armories will be protected with automatic sprinklers unless approved in the FHA when the introduction of water through the sprinkler system creates a greater hazard. The sprinkler piping into an armory may be valved to permit isolation of the system in the event of an emergency when approved by the Cognizant Office of Responsibility.

15-13.1.4 Security Doors

Security doors into armories will be evaluated by a qualified fire protection engineer to determine if a door may be considered as equivalent to that of a 1.5-hour-rated fire door. Use of security doors for this purpose must be approved by the Cognizant Office of Responsibility.

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CHAPTER 16 EARTH-COVERED MAGAZINE (ECM) STRUCTURES

NOTE: Cognizant Offices of Responsibility for this chapter are AFCEC and AFSEC.

16-1 SCOPE

This chapter includes requirements in addition to the requirements (unless otherwise specified) of Chapters 1 through 13 that are applicable to ECM structures where nuclear weapons are authorized to be stored but not tested or maintained.

16-2 ARCHITECTURAL REQUIREMENTS

16-2.1 Uniform Minimum Ammunition and Explosive (AE) Safety Standards

Uniform minimum AE safety standards established by the Department of Defense Explosives Safety Board (DDESB) will be incorporated.

NOTE: The DDESB has established uniform minimum AE safety standards for personnel and property that have the potential of being exposed to the effects of an accidental explosion. These standards govern the design, construction, and use of all AE storage magazines within DoD.

16-2.2 ECM Siting

ECM structures will be sited using DDESB uniform minimum AE safety standards.

16-2.3 Hardened Fire Protection Systems

Buildings will be provided with hardened fire suppression systems in all areas and smoke detection systems (refer to Chapter 11 and Appendix B).

NOTE: ECM structures are built to store AE. ECM structures are not necessarily designed to contain the damaging effects from an internal explosion, although these structures will usually contain the effects of a very small quantity of AE. Instead, ECMs are intended to protect their contents from an explosion that may occur in an adjacent structure, such as another ECM, piers, aboveground magazines, rail sidings, or classification yards. The ECM may not be adequate to prevent damage to its contents from all external events. Protection from such events should be addressed in the FHA.

16-3 APPROVAL REQUIREMENTS

16-3.1 DDESB Review

Plans for ECM structure modification and new construction must be reviewed and approved by the local wing weapons safety office in accordance with AFMAN 91-201. The ECM modification or new construction will be included in a site plan package that will be reviewed and approved by the DDESB to ensure that minimum DoD explosive safety considerations have been addressed. Situations requiring approval include:

- New construction or major modification
- Changes in use of facilities that affect the siting separation distances

16-3.2 Pre-approved ECM Designs

If pre-approved ECM designs are used, the project site plan and the drawing numbers of the ECM design must be submitted for approval. All new 7- and 3-bar ECM designs must be approved by the DDESB before they may be used. The approval will require the submission of test results or detailed structural calculations.

16-3.3 Undefined ECM Designs

All new, undefined ECM designs require prior approval from the DDESB to ensure that minimum design and construction criteria are met.

16-4 LIFE SAFETY AND MEANS OF EGRESS

NOTE: Cognizant Offices of Responsibility for this paragraph are AFCEC and AFSEC.

16-4.1 Life Safety Performance Criteria

These performance criteria will be met during all operational modes and ECM configurations:

- Provide safe egress for all occupants of the facility.
- Provide adequate protection, including emergency lighting and communication, for essential personnel to perform necessary weapons safety and security functions in case of a fire event.

NOTE: Typical DoD ECMs are small structures that are occupied only for brief periods to permit the addition or removal of weapons systems from the structure. The weapons systems are then transported to an industrial facility (refer to Chapter 15), an underground facility (refer to Chapter 14), or transported off the DoD installation. The only other expected periods of occupancy will be temporary access by a limited number of personnel to perform maintenance on the ECM's infrastructure systems. Otherwise, security measures will effectively prevent access by all personnel to the ECM. Life safety performance criteria provided in the FHA should incorporate such operational considerations.

16-4.2 Occupancy Classification

ECM structures used for the storage of nuclear weapons will be considered special-purpose industrial occupancies.

16-4.3 Occupant Load

In determining the exiting requirements for a nuclear weapons-capable maintenance and storage facility, the actual number of assigned personnel and expected number of security personnel during operations in the ECM with an added safety factor of 20 percent will be used to determine occupant load in lieu of other criteria within NFPA 101.

16-4.4 Number of Means of Egress

One means of egress from an ECM is permitted.

16-4.5 Travel Distances

Travel distances to an exterior exit must not exceed 400 feet (122 meters) for facilities protected throughout by an automatic fire suppression system. For facilities not protected throughout by an automatic fire suppression system, travel distances to an exterior exit must not exceed 200 feet (61 meters).

16-4.6 Common Path of Travel

The common path of travel distance is not limited.

16-4.7 Dead-End Corridors

Dead-end corridors are not permitted.

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CHAPTER 17 COMBINED MAINTENANCE AND STORAGE FACILITIES

NOTE: Cognizant Office of Responsibility for this chapter is AFCEC unless otherwise specified.

17-1 SCOPE

This chapter includes requirements in addition to the requirements (unless otherwise specified) of Chapters 1 through 13 that are applicable to restricted access/egress facilities where combined maintenance and storage activities such as inspection, testing, fueling, and periodic maintenance take place. This type of facility is located at ground level but portions of the facility exterior walls are strengthened to resist an exterior threat in accordance with DoDM S-5210.41 / AFMAN 31-108. For facilities that are located underground, comply with Chapter 14 in lieu of this chapter.

17-2 ARCHITECTURAL REQUIREMENTS

17-2.1 Construction Type

Buildings will be constructed to be fire-resistant or noncombustible (Type I or Type II in accordance with the IBC). All walls, floors, and structural components, except interior finish materials in office and support areas, will be of noncombustible construction. Use of combustible interior finishes will be minimized.

17-2.2 Fire Areas

NOTE: Cognizant Offices of Responsibility for this paragraph are AFCEC and AFSEC.

Facilities capable of inspecting, maintaining or storing nuclear weapons components will be subdivided into separate fire areas to minimize the risk of fire spread and the resultant consequential damage from fire gases, smoke, heat, radioactive contamination, and firefighting activities. In addition, the subdivision into fire areas will allow adequate access for manual fire suppression activities and be as consistent as possible with the blast zones (when provided).

17-2.2.1 Establishment of Boundaries

The boundaries of fire areas will be established in the FHA based on general fire protection criteria that include these elements:

- Types, quantities, density, and locations of combustible and flammable materials, and of radioactive materials
- Location of blast doors (if provided)
- Location of security access portals
- Location and configuration of equipment
- Consequences of inoperable equipment

- Location or zoning of fire detection and suppression systems
- Personnel safety, exiting, and area of refuge requirements
- Building separations and occupancy separation requirements

17-2.2.2 Boundary Objectives

In limited-access combined industrial and storage facilities, fire area boundaries will accomplish fire protection objectives, including:

- To separate all contiguous buildings or portions thereof serving different purposes, such as storage, maintenance, service, administration, and other occupancy designations
- To separate weapons storage areas from adjacent areas
- To separate weapons maintenance areas from adjacent areas
- To separate fueling areas from adjacent areas
- To separate security and other control rooms, computer rooms, or combined control and computer rooms from adjacent areas
- To separate rooms with major concentrations of electrical equipment, such as switchgear rooms and relay rooms, from adjacent areas
- To separate battery rooms from adjacent areas
- To separate each fire pump and its associated equipment from all other pumps in the same room or pump house
- To separate each fire pump from adjacent areas
- To separate warehouse areas and combustible storage areas from adjacent areas
- To separate standby or emergency power generators from each other and from adjacent areas
- To separate fan rooms and plenum chambers from adjacent areas
- To separate office areas from adjacent areas

17-2.2.3 Fire Barriers Separating Fire Areas

Fire barriers separating fire areas must be of a minimum 3-hour fire resistance rating with listed 3-hour-rated penetration seals.

17-2.2.4 Fire Doors and Fire Windows in Fire Barriers

Fire doors and fire windows used in fire barriers will be installed and maintained in accordance with NFPA 80. In the case of blast doors in fire barriers, refer to paragraph 7-4.3.8.

Normally, closed fire doors in fire barriers will be identified with a sign indicating, “Fire Door — Keep Closed.”

Windows in fire barriers, such as for a security control room or computer room, will be provided with a listed or approved fire shutter, automatic wall curtain, or fire resistance glazing.

17-2.3 Vertical Shafts and Plenums

To prevent vertical spread of fire, all stairways, elevator shafts, escape ladders, and other vertical shafts and plenums will be enclosed with barriers having a fire resistance rating of at least 2 hours. Openings in such barriers will be protected with listed automatic or self-closing fire doors having a fire protection rating of at least 1.5 hours.

17-3 COMBUSTIBLE MATERIALS AND FINISHES

17-3.1 Areas Where Weapons Are Maintained or Stored

Combustible materials, other than materials fully contained within and designed to serve as part of the weapon or weapon delivery vehicle/system, must be excluded from fire areas designated for weapon maintenance and storage except for incidental amounts of combustible materials as determined by the FHA. Such incidental amounts might include solid wood blocks that serve as chocks for weapons support or small amounts of solvent used for weapons maintenance.

17-3.2 Blast Shielding Materials

Permanent and temporary shielding materials must be noncombustible or limited combustible, based on:

- ASTM E84
- NFPA 253
- NFPA 255
- UL 94

Polystyrene used for sand walls is not required to be encased with fire-resistant materials.

17-3.3 Interior Finishes

17-3.3.1 Interior Wall and Ceiling Finish

Interior wall and ceiling finish in areas processing or storing radioactive materials will be Class A in accordance with NFPA 255.

NOTE: The design should consider a potential radiation contamination incident and include wall and ceiling finishes that are easy to clean.

17-3.3.2 Interior Floor Finish

Interior floor finish in areas processing or storing radioactive materials will be Class I in accordance with NFPA 253. If required to meet weapon maintenance environmental conditions, anti-static flooring having less than a Class I fire rating is permitted when approved by the Cognizant Office of Responsibility.

NOTE: The design should consider a potential radiation contamination incident and include floor finishes that are easy to clean.

17-3.4 Other Materials

Thermal insulation materials, radiation shielding materials, ventilation duct materials, soundproofing materials, and suspended ceilings, including light diffusers and their supports, will be noncombustible or limited combustible. If polypropylene or polyethylene is required for neutron shielding, it must be totally encased with a noncombustible material such as steel or 5/8-inch (16-millimeter) type X gypsum board. Approximately 3/8-inch (10-millimeter) vent holes must be provided within the encasement to permit the venting of gases from the poly material.

NOTE: Encasement is required because many plastic materials, including flame- and fire-retardant materials, will burn with an intensity and energy production in the range similar to that of ordinary hydrocarbons. When burning, these materials produce heavy smoke that obscures visibility and can plug air filters, especially charcoal and HEPA filters. When burning, halogenated plastics also release free chloride and hydrogen chloride. These gases are toxic to humans and corrosive to equipment.

17-4 HAZARD CONTROL

17-4.1 Flammable and Combustible Liquids

17-4.1.1 Where oil-burning equipment, stationary combustion engines, or gas turbines are used, they will be installed and used in accordance with NFPA 31 or NFPA 37, as appropriate.

17-4.1.2 Flammable and combustible liquid and gas piping will be in accordance with ANSI B31.1 or the ASME *Boiler and Pressure Vessel Code*, Section III, as applicable.

17-4.2 Hydraulic Systems

Hydraulic systems must use only listed fire-resistant hydraulic fluids.

17-4.3 Solvents

Where a flammable or combustible solvent is used, it must be handled such that the uncontrolled release of vapors is not permitted.

17-4.4 Gases

Flammable and combustible gases will be stored and handled in accordance with NFPA 54, NFPA 55, and NFPA 58.

Bulk flammable gas storage, either compressed or cryogenic, will not be permitted inside structures capable of maintaining or storing nuclear weapons.

Storage of flammable gas, such as hydrogen, will be located outdoors or in separate detached buildings so a fire or explosion will not adversely affect any nuclear weapons maintenance and storage facility systems or equipment.

17-4.5 Automatic Sprinkler System

In addition to the requirements of Chapter 11 of this document, provide a conventional wet-pipe sprinkler system designed for Extra Hazard Group 1 occupancy (0.3 gpm/ft^2 over 2500 ft^2 [12.2 mm/min over 232 m^2]) for all areas subject to maintenance, fueling, transport, or storage for fueled weapons delivery vehicles/systems.

17-5 REFUELING AREAS

17-5.1 Automatic Foam Fire Suppression

An automatic, local application, foam fire suppression system will be provided. The system will protect the area from the hazards defined within the FHA and be designed in accordance with NFPA 11. Foam concentrate and water will be provided to permit continuous operation of the system for 30 minutes. Activation of the foam discharge will be accomplished by a fire detection system meeting the requirements of Chapter 11. A pressure proportioning-type foam concentrate tank must be utilized for the foam system. High-expansion foam (if used) will be discharged at a rate to cover the hazard by least 2 feet (0.6 meter) within two minutes, and air to the high-expansion foam generator may be supplied from either within or exterior to the refueling area.

17-5.2 Electrical Equipment

Electrical equipment will comply with NFPA 70, including Chapter 5, “Special Occupancies,” and other NFPA 70 requirements related to hazardous locations.

17-5.3 Fuel Transfer Pumps

Where pumps are used for liquid fuel transfer, means will be provided to shut down liquid transfer in the event of a spill or fire.

17-5.4 Fuel Holding Tanks

Fuel holding tanks (i.e., operationally required tanks) located within refueling areas must not exceed 200 gallons (757 liters) per tank, with a maximum of two fuel holding tanks per refueling area.

Fuel holding tanks will be equipped with overfill protection.

17-5.5 Fuel Line Shutoff

Fuel supply lines entering refueling rooms will be arranged with a spring-loaded automatic shutoff valve that is activated via a fusible link.

17-5.6 Containment in Refueling Rooms

Refueling rooms will be designed to capture the entire contents of the fuel within the refueling room and the discharge of automatic fire sprinkler and foam fire suppression systems for 30 minutes. Drainage to a separate location must be approved by the Cognizant Office of Responsibility.

17-5.7 Ventilation

17-5.7.1 General

Refueling rooms will be provided with either a gravity system or a continuous mechanical exhaust ventilation system.

17-5.7.2 Exhaust Location

Exhaust air will be taken from a point near a wall on one side of the room and within 12 inches (30.5 centimeters) of the floor, with one or more make-up inlets located on the opposite side of the room within 12 inches (30.5 centimeters) of the floor.

17-5.7.3 Air Openings

The location of both the exhaust and inlet air openings will be arranged to provide air movement across all portions of the floor to prevent the accumulation of vapors.

17-5.7.4 Recirculation

Exhaust from the room must be conducted directly to the exterior of the building and must not be recirculated.

17-5.7.5 Ducts

If ducts are used, they must not be used for any other purpose and will comply with NFPA 91.

17-5.7.6 Make-Up Air

If make-up air to a mechanical system is taken from within the building, the opening must be equipped with a fire door or damper as required in NFPA 91.

17-5.7.7 Gravity Systems

For gravity air systems, the make-up air must be supplied from outside of the building.

17-5.7.8 Capacity

Mechanical ventilation systems must provide at least 1 cubic foot per minute (28.3 liters per minute) of exhaust air for each square foot (0.09 square meter) of floor area, but not less than 150 cubic feet per minute (4,248 liters per minute).

17-5.7.9 Dispensing Areas

The mechanical ventilation system for dispensing areas will be equipped with an airflow switch or other equally reliable method that is interlocked to sound an audible alarm upon failure of the ventilation system.

17-5.7.10 Air Intake Height

The minimum height of air intakes in these areas will be in accordance with UFC 4-010-01.

17-5.8 Static Electricity

Means will be provided to minimize the generation of static electricity in the refueling area. See AFI 91-203, NFPA 77, and NFPA 407.

17-6 LIQUID RUN-OFF CONTROL

NOTE: Cognizant Offices of Responsibility for this paragraph are AFCEC and AFSEC.

Drainage must be provided in all areas of the facility for the removal of all liquids directly to safe areas, or for containment in the area and without endangering other areas. (See paragraph 17-7.6.)

17-6.1 Methods

Drainage and the prevention of equipment water damage will be accomplished by one or more of these methods:

- Floor drains
- Floor trenches
- Open doorways or other wall openings
- Curbs for containing or directing drainage
- Equipment pedestals
- Pits, sumps, and sump pumps

17-6.2 Sump Pump Systems

Waste and drainage sump pump systems will be provided with 100 percent redundant pumps.

17-6.3 Drainage and Drainage Facility Size

Drainage and any associated drainage facilities for a given area will be sized to accommodate the volume of liquid produced by all of these sources:

- The spill of the largest single container of any flammable or combustible liquids in the area (see paragraph 17-6.6 for refueling rooms)
- The credible volume of discharge (as determined by the FHA) released by the automatic suppression system operating for a period of 30 minutes, unless the approved FHA authorizes a different flow rate and duration
- The contents of piping systems and containers that could fail in a fire
- The volume of water discharged based on a manual firefighting flow rate of 500 gallons per minute (1,890 liters per minute) for 30 minutes unless the approved FHA authorizes use of a different flow rate and duration
- For areas open to the outside, such as underground loading docks, credible environmental factors such as rain and snow

17-6.4 Staging Equipment

Necessary equipment must be staged to assist with routing water from the affected area. The use of the staging equipment will be addressed in the fire department pre-fire plan.

17-6.5 Floor Drainage

Floor drainage from areas containing flammable or combustible liquids must be trapped to prevent the spread of burning liquids beyond the fire area.

17-6.5.1 Areas with Radioactive Materials

Floor drainage from storage and maintenance areas capable of containing nuclear weapons components must be trapped to prevent the spread of radioactive materials beyond the facility's controlled boundaries.

Water drainage from areas that might contain radioactivity must be collected, sampled, and analyzed before discharge to the environment or outside the boundaries of the facility.

Water released during fire suppression operations in areas containing radioactivity must be drained to a location that would be acceptable for the containment of radioactive materials.

17-6.6 Criticality Hazards

NOTE: The Cognizant Office of Responsibility for this paragraph is AFSEC.

Nuclear weapons-capable storage and maintenance areas will be designed to be criticality safe if required by the Cognizant Office of Responsibility, including consideration of the operation of automatic sprinklers and other fire suppression systems. Floor drains must be provided. Appropriate drain lines, storage, and handling systems capable of handling potentially contaminated water must be provided.

17-7 THROUGH PENETRATION FIRE STOPS

17-7.1 Where Required

17-7.1.1 Penetrations

Fire stops for penetrations such as pipes, conduits, bus ducts, cables, wires, pneumatic tubes and ducts, and similar building service equipment that passes through fire barriers will be provided to prevent the spread of fire using listed or approved materials (caulking) or devices (sleeves).

17-7.1.2 Blast-Resistant Barrier

If the fire barriers coincide with or are also serving as a blast-resistant barrier, these penetrations will also require blast-resistant devices. If the blast-resistant device is sufficient to serve as protection from the spread of fire, no additional protection is necessary. If the blast-resistant penetration device is not listed or approved for fire penetrations, it can be evaluated by a qualified fire protection engineer and accepted as a fire barrier product by the Cognizant Office of Responsibility.

17-7.2 Annular Spaces

The annular space between the penetrating item and the through opening in the fire barrier must be filled with a qualified (listed or approved) fire-resistive penetration seal

assembly capable of maintaining the fire resistance of the fire barrier. The assembly must be qualified by tests in accordance with fire test protocols or be protected by a listed fire-rated device for the specified fire-resistive period. Penetration seals provided for electrical and mechanical openings must be listed as meeting the requirements of ASTM E814 or UL 1479.

17-7.3 Conduit Seals

Refer to Chapter 3.

17-7.4 Leak Testing

Open flame- or combustion-generated smoke will not be used for leak testing.

17-8 COMMUNICATIONS

NOTE: Cognizant Office of Responsibility for this paragraph is AFSEC.

Communication systems using a lossy antenna distribution system within the facility will be limited as much as possible and must be within the allowable EMR limits of the STS.

All electrical equipment and devices are either intentional or unintentional EMR emitters as defined in Chapter 8. All such equipment to be used in close proximity to critical equipment interior to the facility must not exceed the allowable EMR limits of the STS. Anticipated EMR emitters must be analyzed to evaluate anticipated EMRE levels. If the EMRE levels exceed allowable limits, facility design, equipment selection, or procedures must be adjusted to mitigate EMRE levels.

17-9 LIFE SAFETY AND MEANS OF EGRESS

NOTE: Cognizant Office of Responsibility for this paragraph is AFCEC.

17-9.1 Life Safety Performance Criteria

The following performance criteria will be met during all operational modes and facility configurations:

- Provide safe egress or areas of refuge for all occupants of the facility.
- Provide adequate protection, including emergency lighting and communication, for essential personnel to perform necessary weapons safety and security functions in case of a fire event.

17-9.2 Occupancy Classification

17-9.2.1 Industrial facilities involved in the inspection, testing, and maintenance of nuclear weapons and weapon delivery vehicles/systems will be considered limited-access special purpose industrial occupancies as defined in NFPA 101.

17-9.2.2 Those areas involved in the storage of nuclear weapons and weapons delivery vehicles/systems will be considered limited-access special purpose industrial occupancies as defined in NFPA 101.

17-9.2.3 Support and storage areas designated for the storage of materials other than nuclear weapons will conform to the ordinary hazard storage occupancy (refer to Chapters 6 and 42 of NFPA 101) and, if applicable, limited-access requirements in NFPA 101.

17-9.2.4 General office areas, break rooms, security control rooms, and training areas will conform to the business occupancy requirements, and, if applicable, limited-access requirements in NFPA 101.

17-9.3 Occupant Load

In determining the exiting requirements for a limited-access nuclear weapons-capable maintenance and storage facility, the actual number of assigned personnel and expected number of visitors during operations, maintenance, and testing with an added safety factor must be used to determine occupant load in lieu of other criteria within NFPA 101. The safety factor will be 30 percent for maintenance areas and 20 percent for storage areas.

17-9.4 Number of Means of Egress

17-9.4.1 Fire areas designated as not limited-access must have at least two means of egress.

17-9.4.2 A single means of egress will be permitted from any story or section of a non-restricted access/egress fire area, provided the exit can be reached within 100 feet (30 meters) and when the single means of egress is approved by the Cognizant Office of Responsibility.

17-9.4.3 Limited-access fire areas must have at least one means of egress. When nuclear security requirements prohibit the use of approved egress components (such as a listed fire door meeting the requirements of NFPA 101) for the means of egress, an area of refuge must also be provided within the fire area (see paragraph 17-10.6).

17-9.4.4 Refueling room must have not less than two means of egress.

17-9.5 Horizontal Exit

A horizontal exit will be considered to be any adjacent fire area separated by at least 3-hour fire-rated construction and accessible through listed fire doors meeting the requirements of NFPA 101 and NFPA 80.

17-9.6 Area of Refuge

An area of refuge will:

- Be separated from adjacent areas by at least 3-hour fire-rated construction
- Minimize the entrance of smoke
- Be protected throughout by automatic sprinklers
- Be provided with two-way communication (including instructions on the operation of the equipment)

An area of refuge must be provided with protective heat-resistant clothing, emergency drinking water, and sufficient breathing air to permit survival for at least 72 hours based on the expected occupant load. The occupant capacity for the area of refuge will be established in the FHA.

NOTE: When possible, the area of refuge within a fire area should be located near the nuclear security access doors into the fire area.

17-9.7 Travel Distances

For weapon maintenance and storage areas, travel distances to an exterior exit, horizontal exit, or area of refuge within the fire area must not exceed 400 feet (122 meters).

For refueling rooms, travel distances to an exit must not exceed 75 feet (23 meters).

For all other limited-access areas, travel distances to an exterior exit, horizontal exit, or area of refuge within the fire area must not exceed 300 feet (91 meters)

17-9.8 Common Path of Travel

For weapon storage areas, common path of travel distances are not limited. For all other limited-access areas, the common path of travel must not exceed 100 feet (30 meters).

17-9.9 Dead-End Corridors

For restricted access/egress areas, dead-end corridors distances are not limited, provided travel distances and common path of travel distances are not exceeded. For all other areas, dead-end corridors must not exceed 50 feet (15 meters).

17-9.10 Special Locking Devices

Special locking devices (such as dead bolts and slide bolts) may be installed and left engaged on exit doors during periods of occupancy in addition to the normal door locking devices, provided that the devices are required by security, are clearly visible to the building occupants, and the building occupants are advised of their presence.

NOTE: Such locking devices should be marked or painted with a bright contrasting color (e.g., orange, yellow, red) to be clearly visible to the occupants.

17-10 ELECTROEXPLOSIVE DEVICES (EED)

NOTE: Cognizant Offices of Responsibility for this paragraph are AFCEC and AFSEC.

17-10.1 Storage and Testing Area Criteria

Areas where EEDs are stored or tested will meet the following criteria:

17-10.1.1 Separation

EED areas will be designed to withstand the internal explosive hazard and will be separated from the remainder of the facility by not less than 3-hour-rated walls.

17-10.1.2 Seals

All permanent penetrations into and out of the room must be sealed by a listed or approved means (i.e., penetration seals, fire and smoke dampers).

Penetrations that are provided for use in remote testing or remote electrical testing may be covered with a movable steel door or “flap” that is configured with a small slit that allows temporary wiring needed for the testing to penetrate the wall.

17-10.1.3 Ventilation Ductwork

Ventilation ductwork that penetrates the room must be equipped with fire or combination fire and smoke dampers with at least a 3-hour fire rating. Alternate means of protection of the ductwork (i.e., without dampers) are not permitted.

17-10.1.4 Blast Doors

Blast doors will be designed to withstand the internal explosive hazard and be evaluated by a qualified fire protection engineer to determine if the door may be considered as equivalent to that of a 3-hour-rated fire door. Use of the blast doors for this purpose must be approved by the Cognizant Offices of Responsibility.

17-10.1.5 Fire Suppression

The room will be protected by an automatic sprinkler fire suppression system.

NOTE: The sprinklers should be supplied from above the ceiling and also provided with sprinkler guards. These features will help reduce damage to the sprinkler system due to explosion.

17-10.1.6 Grounding

Grounding or bonding to an earth ground must be provided (see Chapter 3).

17-10.2 Deflagration Venting

Areas where EEDs are stored or tested must be provided with deflagration venting in accordance with NFPA 68.

17-11 ARMORIES

17-11.1 Fire Rating

Armories must be separated from the remainder of the facility by a minimum of 2-hour fire-rated construction and 1.5-hour-rated fire doors.

17-11.2 Fire Stops

Penetrations into armories will be fire stopped (e.g., fire dampers, penetration seals) in addition to security requirements.

17-11.3 Automatic Sprinklers

Armories must be protected with automatic sprinklers. The sprinkler piping into an armory may be valved to permit isolation of the system in the event of an emergency when approved by the Cognizant Office of Responsibility.

17-11.4 Security Doors

Security doors into armories will be evaluated by a qualified fire protection engineer to determine if a door may be considered as equivalent to that of the required fire-rated door. Use of the security doors for this purpose must be approved by the Cognizant Office of Responsibility.

17-12 FIRE HYDRANTS FOR ENTRY/EXIT POINTS

Fire hydrants will be installed within approximately 50 feet (15 meters) of each entry/exit point for over-the-road vehicle loading dock.

17-13 SECURITY CONTROL ROOM COMPLEX

See Chapter 5 for security control room complex requirements.

17-14 COMMUNICATIONS

For all communication systems that are wireless or EMR emitting devices, the restrictions within Chapter 8 will be implemented as appropriate.

Prior to the introduction of wireless devices, the devices must be reviewed by the Host Wing, Weapons Safety Office.

APPENDIX A REFERENCES

AIR FORCE

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

AFI 32-1062, *Electrical Systems, Power Plants, and Generators*

AFI 32-1065, *Grounding Systems*

AFI 32-10141, *Planning and Programming Fire Safety Deficiency Correction Projects*

AFI 33-360, *Publications and Forms Management*

AFI 63-125, *Nuclear Certification Program*

AFI 90-201, *The Air Force Inspection System*

AFPD 91-1, *Nuclear Weapons and Systems Surety*

AFI 91-101, *Air Force Nuclear Weapons Surety Program*

AFI 91-102, *Nuclear Weapon System Safety Studies, Operational Safety Reviews, and Safety Rules*

AFI 91-103, *Air Force Nuclear Safety Design Certification Program*

AFI 91-107, *Design, Evaluation, Troubleshooting, and Maintenance Criteria for Nuclear Weapon Systems*

AFI 91-116, *Safety Rules for Long-Term Storage and Maintenance Operations for Nuclear Weapons*

AFI 91-202, *The US Air Force Mishap Prevention Program*

AFMAN 91-118, *Safety Design and Evaluation Criteria for Nuclear Weapon Systems*

AFMAN 91-119, *Safety Design and Evaluation Criteria for Nuclear Weapon Systems Software*

AFMAN 91-201, *Explosives Safety Standards*

AFI 91-203, *Air Force Consolidated Safety Instruction*

DEPARTMENT OF DEFENSE

DoD 6055-09-M, *DoD Ammunition and Explosives Safety Standards*, http://www.esd.whs.mil/Directives/issuances/dodm/

DoD S-5210.41 / AFMAN 31-108, Volumes 1–3, *Nuclear Weapon Security Manual: The Air Force Nuclear Weapon Security Manual*, http://www.esd.whs.mil/Directives/issuances/dodm/

DoDD 3150.02, *DoD Nuclear Weapon Surety Program*, http://www.esd.whs.mil/Directives/issuances/dodd/

DoDM 3150.02, *DoD Nuclear Weapon System Safety Program Manual*, http://www.esd.whs.mil/Directives/issuances/dodm/

DoDD 6055.9E, *Explosives Safety Management (ESM)***,** http://www.esd.whs.mil/Directives/issuances/dodd/]

DoDI 6055.06, *DoD Fire and Emergency Services (F&ES) Program*, http://www.esd.whs.mil/Directives/issuances/dodi/

MIL-STD-3007F, *Standard Practice for Unified Facilities Criteria and Unified Facilities Guide Specifications*, http://wbdg.org/ffc/dod/federal-military-specifications-standards/mil-std-3007

DDESB Memorandum, "Minimum Requirements to Validate Explosive Safety Protective Construction," 21 October 2008, https://www.wbdg.org/FFC/dod/ddesb_memo.pdf

DDESB Technical Paper 16, "Methodologies for Calculating Primary Fragment Characteristics," Revision 4, 2 August 2012

UFC 1-200-01, *General Building Requirements,* https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

UFC 3-340-02, *Structures to Resist the Effects of Accidental Explosions*, https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

UFC 3-400-02, *Design: Engineering Weather Data*, https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

UFC 3-401-01, *Mechanical Engineering*, https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

UFC 3-410-01, *Heating, Ventilation, and Air Conditioning Systems*, https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

UFC 3-501-01, *Electrical Engineering,* https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

UFC 3-520-01, *Interior Electrical Systems,* https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

UFC 3-520-05, *Stationary Battery Areas,* https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

UFC 3-550-01, *Exterior Electrical Power Distribution,* https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

UFC 3-600-01, *Fire Protection Engineering for Facilities*, https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

UFC 4-010-01, *DoD Minimum Antiterrorism Standards for Buildings,* https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

UFC 4-021-01, *Design and O&M: Mass Notification Systems,* https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

DEPARTMENT OF ENERGY

https://www.directives.doe.gov/directives-browse#c10=&b_start=0

DOE O 420.1C*, Facility Safety*

DOE O 440.1B, *Worker Protection Program for DOE (Including the National Nuclear Security Administration) Federal Employees*

DOE-STD-1066-2012, *Fire Protection*, http://energy.gov/ehss/downloads/doe-std-1066-2012

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

https://www.asme.org/shop/standards

ASME AG-1, *Code on Nuclear Air and Gas Treatment*

ASME *Boiler and Pressure Vessel Code*

ASME B31.1, *Power Piping*,

ASTM INTERNATIONAL

http://www.astm.org/

ASTM D1298, *Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method*

ASTM D1524, *Standard Test Method for Visual Examination of Used Electrical Insulating Liquids in the Field*

ASTM D1533, *Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration*

ASTM D1816, *Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes*

ASTM D3612, *Standard Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography*

ASTM D877, *Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes*

ASTM D924, *Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids*

ASTM D971, *Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method*

ASTM D974, *Standard Test Method for Acid and Base Number by Color-Indicator Titration*

ASTM E814, *Standard Test Method for Fire Tests of Penetration Firestop Systems*

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*

INTERNATIONAL CODE COUNCIL

International Building Code (IBC), http://www.iccsafe.org

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS

IEEE 383, *IEEE Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Facilities*, http://standards.ieee.org/findstds/standard/383-2015.html

IEEE C57.104, *Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers*, http://standards.ieee.org/findstds/standard/C57.104-2008.html

IEEE C2, *National Electrical Safety Code*, http://standards.ieee.org/about/nesc/index.html

NATIONAL FIRE PROTECTION ASSOCIATION

http://catalog.nfpa.org/

Fire Protection Handbook

Gewain, R.G., Shanley, J.H., DiNenno, P.J., Scheffey, J.L., and Campbell, B.G., "Evaluation of Duct Opening Protection in Two-Hour Fire Walls and Partitions," *Fire Technology*, 27 (3), August 1991

NFPA 10, *Standard for Portable Fire Extinguishers*

NFPA 11, *Standard for Low-, Medium- and High-Expansion Foam*

NFPA 13, *Standard for the Installation of Sprinkler Systems*

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*

NFPA 30, *Flammable and Combustible Liquids Code*

NFPA 31, *Standard for the Installation of Oil-Burning Equipment*

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*

NFPA 54, *National Fuel Gas Code*

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*

NFPA 58, *Liquefied Petroleum Gas Code*

NFPA 68, *Standard on Explosion Protection by Deflagration Venting*

NFPA 70, *National Electrical Code*

NFPA 72, *National Fire Alarm and Signaling Code*

NFPA 77, *Recommended Practice on Static Electricity*

NFPA 80, *Standard for Fire Doors and Other Opening Protectives*

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids*

NFPA 101, *Life Safety Code*

NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*

NFPA 252, *Standard Methods of Fire Tests of Door Assemblies*

NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*

NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*

NFPA 259, *Standard Test Method for Potential Heat of Building Materials*

NFPA 407, *Standard for Aircraft Fuel Servicing*

NFPA 550, *Guide to the Fire Safety Concepts Tree*

NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*

NFPA 750, *Standard on Water Mist Fire Protection Systems*

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

NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*

NFPA 804, *Standard for Fire Protection for Advanced Light Water Reactor Electric Generating Plants*

NFPA 805, *Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants*

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*

SOCIETY OF FIRE PROTECTION ENGINEERS

SFPE Handbook of Fire Protection Engineering, http://www.sfpe.org/page/Handbook5thEdition

UNDERWRITERS LABORATORIES

http://ulstandards.ul.com/standards-catalog/

UL 94, *Standard for Tests of Flammability of Plastic Materials for Parts in Devices and Appliances*

UL 586, *Standard for High-Efficiency, Particulate, Air Filter Units*

UL 900, *Standard for Air Filter Units*

UL 1479, *Standard for Fire Tests of Penetration Fire Stops*

APPENDIX B BEST PRACTICES

B-1 GUIDELINES FOR POTENTIALLY SURVIVABLE FIRE PROTECTION SYSTEM ARCHITECTURES

B-1.1 INTRODUCTION

This document defines a spectrum of facility-related requirements for nuclear weapons-capable maintenance and storage facilities. These requirements include, but are not limited to, requirements for design, construction, and maintenance. There are relatively few of these facilities and, since they have unique design features, national consensus standards are either not available or are not applicable to these facilities.

The principles of fire safety required for nuclear weapons-capable maintenance and storage facilities documented herein were developed by collecting and refining criteria from the DoD, fire protection and munitions safety experts, and national consensus fire safety standards. The document requires that an approved fire detection system and suppression system (e.g., automatic sprinkler system, water mist system, or foam-water system) be installed in all areas of the facility unless shown to be unnecessary in the FHA. The automatic sprinkler system must be designed and installed in accordance with NFPA 13 and UFC 3-600-01.

Water-based fire suppression systems are required to be hardened against possible internal or external damage. This appendix describes different approaches to increase the survivability of a required suppression system and increase the capabilities of a suppression system in a damaged area. Less-conventional, alternative survivable systems for meeting the document's hardening requirements are also described.

B-1.2 OBJECTIVE

The objective of these guidelines is to identify potential approaches to increase the survivability of required water-based fire suppression systems and to identify other potentially more survivable systems for weapons storage facilities.

B-1.3 FACILITY TYPES AND DESCRIPTIONS

B-1.3.1 Facility Types

Several types of nuclear weapons-capable maintenance and storage facilities are discussed in this appendix: ECMs, industrial facilities, and underground facilities. ECMs and underground storage areas are used primarily for storing various munitions. These facilities typically consist of a large, open area with little, if any, floor-to-ceiling compartmentalization. Industrial facilities and portions of underground storage are used for such activities as inspection, maintenance, and testing of munitions. These facilities consist of separated use areas, including administration portions (office spaces), maintenance bays, and mechanical rooms.

B-1.3.2 Compartmented Areas

Facilities capable of storing nuclear weapons and components must be subdivided into separate fire areas to minimize the risk of fire spread and the resultant consequential damage from fire gases, smoke, heat, radioactive contamination, and to aid in firefighting activities. Fire area boundaries must be provided to separate contiguous buildings or portions thereof serving different purposes, such as storage, maintenance, service, administration, and other occupancy areas as dictated by the facility design.

B-1.3.3 Open Areas

ECMs and underground storage areas typically consist of a limited number of large weapon storage areas. These areas can potentially have relatively large footprints.

B-1.4 PERFORMANCE OBJECTIVES

The system can be designed to meet three performance objectives:

- Maintaining capabilities of the system in undamaged areas.
- Containing the fire to the damaged area.
- Controlling or suppressing the fire in the damaged area.

Paragraph B-1.5 identifies approaches and techniques to configure the system to meet some or all of these objectives.

B-1.5 SURVIVABLE ARCHITECTURES

The performance objectives of the system will dictate the required architecture. The systems with the greatest capabilities would be the most complex and expensive. Conversely, systems with reduced capabilities would be the simplest and most economical to design and install. The approaches addressed in this paragraph progress from simple to more complex (i.e., in the order of the performance objectives listed in paragraph B-1.4).

B-1.5.1 Architectures for Maintaining Capabilities in Undamaged Areas

To maintain the capabilities in the undamaged areas, the system must be segregated into fire zones (referred to in this appendix as fire areas). At a minimum, a reliable water supply must be provided. Also, rupture isolation for installed agent piping must be provided. This can be accomplished using flow control valves located within each fire zone boundary.

B-1.5.1.1 Simplest Approach

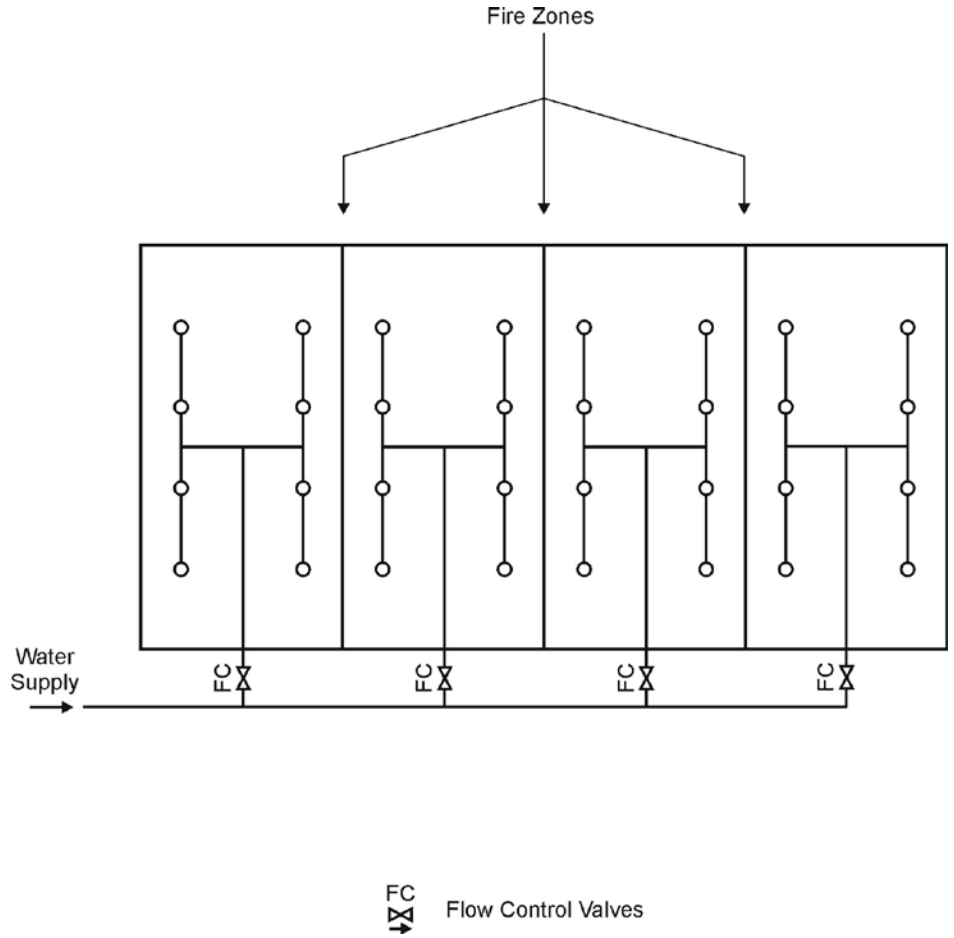
The simplest approach is to install the distribution main and control valves for each zone at a survivable location. These are potentially survivable locations:

- Low in the facility at the junction between the wall and the floor (baseboard)
- Any area that runs the length of the facility that is outside of the potential damage area from the initiating event

Installing the main in the concrete floor slab or even below grade just outside the building may also be options.

Figure B-1 shows a single survivable distribution main located outside of the facility supplied from one end with only a single control valve for each fire zone. Rupture isolation is provided by the control valves for each zone. This approach is adequate only if the distribution main and control valves are outside the damaged area.

Figure B-1 Survivable Distribution Main Architecture

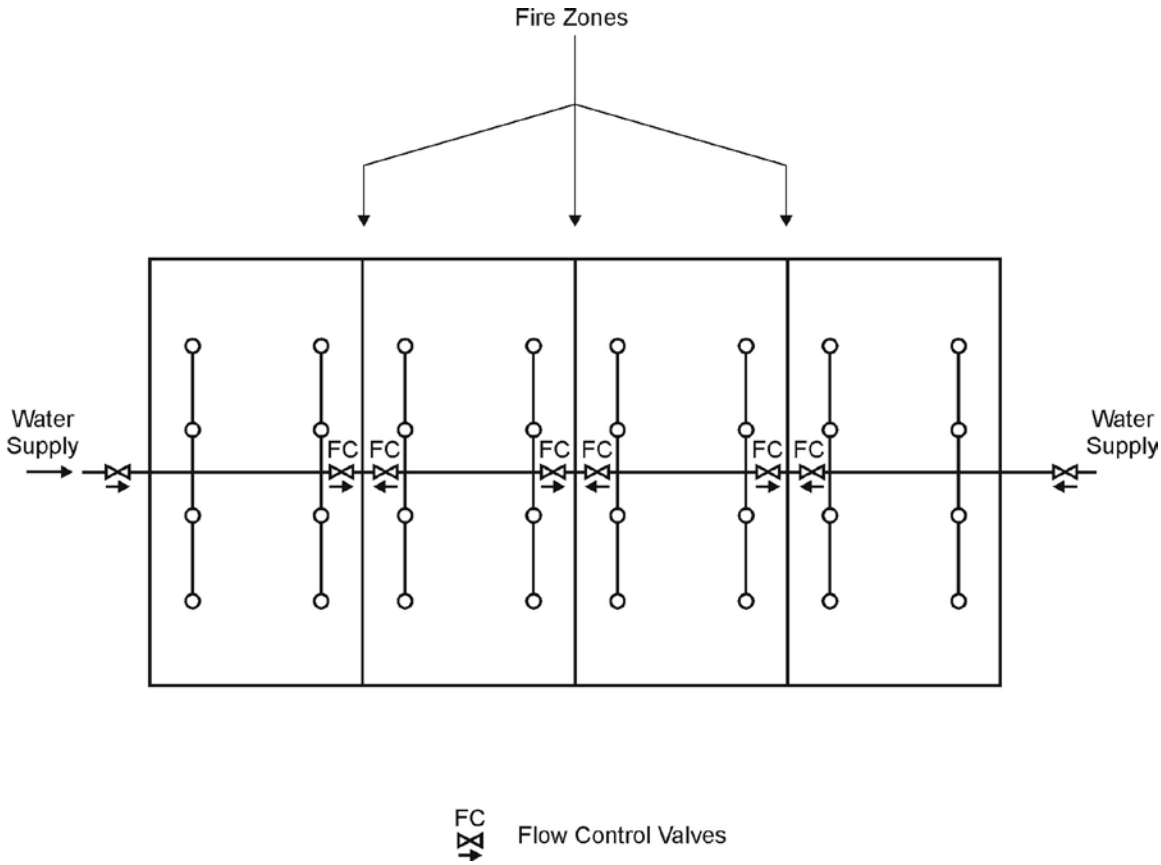


B-1.5.1.2 Alternate Approach

A second approach would be to provide redundant water supplies that enter from opposite ends of the facility. These supplies would feed into opposite ends of a distributed fire main supplying all of the fire suppression systems in the facility.

Figure B-2 shows a single distribution main supplied from opposite ends of the building, with control valves located on both sides of each fire zone boundary.

Figure B-2 Basic Survivable Architecture



B-1.5.1.2.1 Flow Control Valves

These flow control valves can be either manually operated or automatic. Manually operated flow control valves are the simplest and the easiest to install but require a manned response for the system to operate properly. Automatic valves have the advantage of not requiring a manned response but are more expensive. Automatic valves can be either self-contained mechanical or electrical valves (referred to as excess flow valves).

B-1.5.1.2.2 Excess Flow Valves

Excess flow valves automatically close if the flow through the system exceeds a preset value. The simplest type of excess flow valve is a mechanical valve (a spring-loaded piston or flapper) that is pushed closed by the friction produced by the higher flow rates. Electrical excess flow valves (sometimes referred to as smart valves) are equipped with either flow or pressure sensors that assess the flow condition through the valve and automatically secure the valve if the preset value is exceeded. These valves are

expensive and require power to be run to each valve. A backup power supply (i.e., battery) may also be required, depending on the reliability of the primary power supply. These valves are not standard fire protection system components and have been developed and tested by the U.S. Navy and the petroleum industry.

B-1.5.1.2.3 Fully Automated System

A fully automated system is the most complex and expensive. This system consists of electrical valves operated by a separate computerized control system. In addition to the control valves, the pipe network must be instrumented to provide information to the control system. An industrial flow control system used in processing-type facilities could be adapted for this application. In addition, many of the commercially available fire detection and alarm panels can be programmed to control a simple automated system.

B-1.5.2 Architectures for Containing and Combating Fire in the Damaged Area

Maintaining the capabilities of the system in the undamaged zones is the first step in containing the fire to the damaged area. The surviving parts of the system in the undamaged area may not prevent the fire from spreading into the undamaged areas. Specifically, the surviving adjacent zones may not activate until fire has spread into that area.

As currently designed, the adjacent zones have no capabilities against the fire in the damaged area. To obtain these capabilities (containment or suppression of the fire in the damaged area), the system would need to be modified to include additional nozzles, or a new or different system would need to be considered.

B-1.5.2.1 Detection and Control System

Modifying the existing sprinkler system or selecting a new system for this application would result in a more sophisticated and complex system than the conventional sprinkler systems commonly in use. Specifically, the modified or new systems would need to be controlled by a separate detection and control system. This is required since the added component or new system used to combat the fire in the damaged area must be located away from the damage. The fire detection system required in Chapter 11 of this document could be used to control this more sophisticated system, minimizing the cost to obtain these additional capabilities. All of the architectures and systems discussed in the following paragraphs would incorporate the required fire detection system to control the fire suppression system.

B-1.5.2.2 Applicability

The discussion in paragraphs B-1.5.2.3 through B-1.5.2.5 applies only to open areas within the facility. Compartmented areas (office-type spaces, shops, and services areas) are difficult to protect from adjacent zones. This is typically acceptable since the open storage areas are a primary hazard of concern.

As a final point, a conventional automatic sprinkler system may not be the best choice for protecting large, open spaces. Namely, larger fires are required to activate the automatic sprinkler system in open storage areas. This may justify the need for a more sensitive detection system that could be used to control the fire suppression system.

The following paragraphs identify two approaches that can be used to increase the capabilities of the required automatic sprinkler system against a damage scenario.

B-1.5.2.3 Approach 1: Switch to Deluge Sprinkling

Since larger fires are typically required to activate automatic sprinklers in large, open areas, deluge sprinkling may be a better option than thermally activated heads.

B-1.5.2.3.1 System Activation

The detection system installed in the space would activate the system. The activation criteria (for the undamaged system) can be selected based on the ambient conditions in the facility and the nature of the hazard. For example, a default can be to activate the system using 135 degrees F (57 degrees C) intrinsically safe heat detectors. If a more sensitive detection system is required, cross-zoned smoke detectors are an option.

B-1.5.2.3.2 Adjacent Zones

The system can be programmed to automatically discharge water in the zones adjacent to the damaged area. This will help prevent fire spread into these zones or areas by pre-wetting any combustible materials located in these areas.

B-1.5.2.3.3 Flow Rates

Electrical excess flow valves would need to be used for this application (controlled by the detection system) due to the higher flow rates associated with the deluge sprinkling zones. The flow rates of a deluge sprinkling zone may be similar to a damaged system in many scenarios.

B-1.5.2.4 Approach 2: Add Nozzles or Monitors to the Existing System

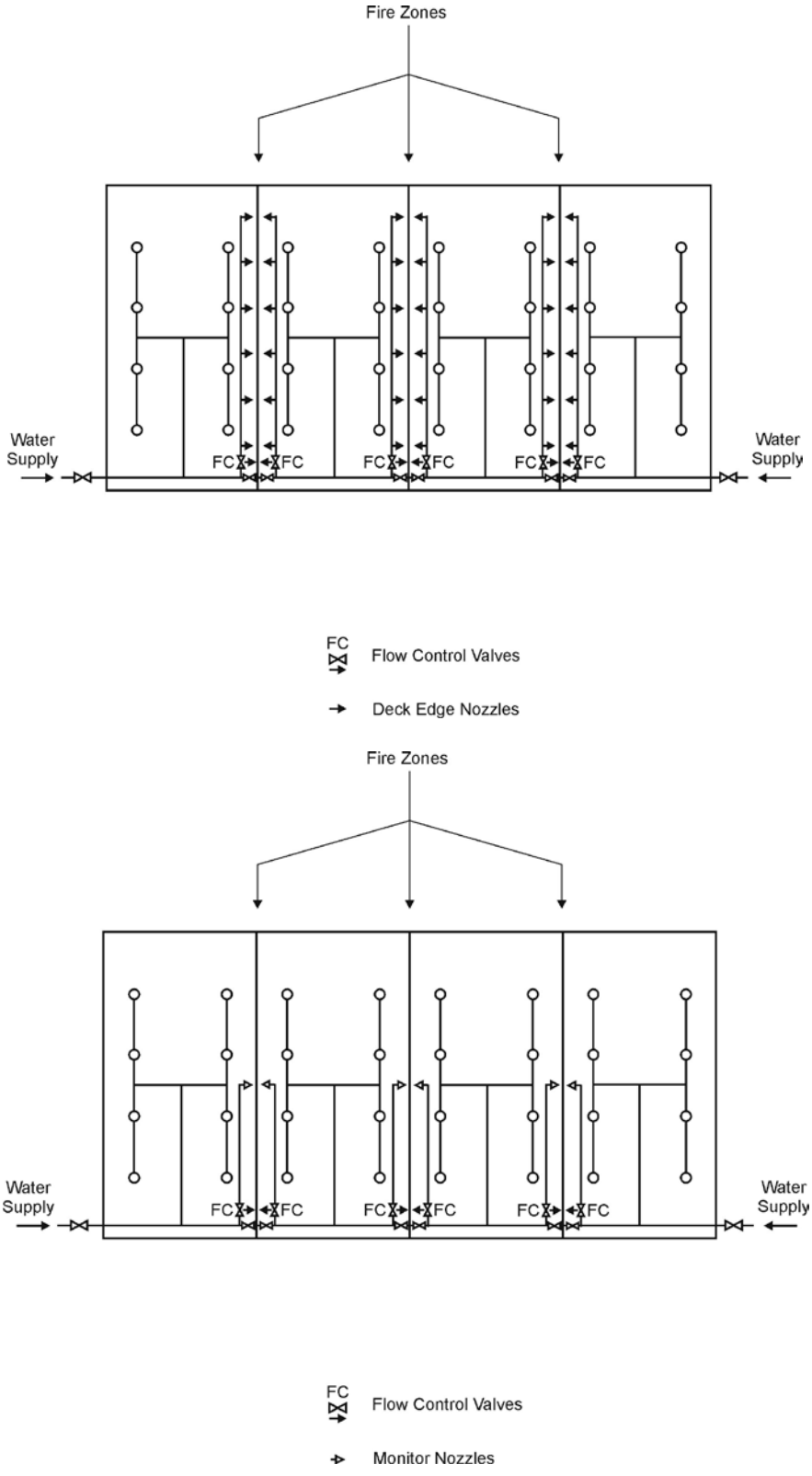
To combat the fire in the damaged area, additional nozzles or monitors would need to be added to the system. These nozzles or monitors would be installed high in the adjacent zones, spraying into the damaged area or zone. If the damaged area or zone is separated from the adjacent zone by a wall, the nozzles or monitors can be installed in the boundary to spray into the damaged area. Acceptability of penetrating the zone boundary must be considered since this is a violation of fundamental zone integrity criteria (i.e., zones are not typically penetrated).

The simplest approach would be to add a line of nozzles on both sides of each fire zone boundary, spraying into the adjacent zone. An approved “deck edge”-type system (the nozzle arrangements used to protect the flight decks of U.S. Navy surface

combatants but installed high in the space) is recommended for this application. Another approach would be to provide one or more 125-gallons-per-minute (473 liters per minute) monitors (depending on the size of the fire zone) on both sides of each fire zone boundary, spraying into the adjacent zone. The monitors must be located at a place that is least likely to be obstructed by the contents in the space. A drawing of the two approaches is provided in Figure B-3.

The branch line containing the supplemental nozzles or monitors would be equipped with an electrically operated valve controlled by the installed fire detection system. The system can be programmed to automatically discharge water into the damaged zone if any or all of the detectors in that zone are reported as damaged (each detector is in “FAULT”). This approach provides the potential to combat the fire in the damaged area.

Figure B-3 Systems That Discharge Water in the Damaged Area



B-1.5.2.5 Aqueous Film-Forming Foam (AFFF)

The default for the two systems (nozzles or monitors) would be to discharge water since they are basically add-ons to the automatic sprinkling system; however, water has only limited capabilities against a potential Class B fire. Specifically, the water would have some effect in controlling the fire but would not be able to suppress or extinguish the fire. To suppress or extinguish the fire, the system would need to discharge aqueous film-forming foam (AFFF).

To add the ability to discharge AFFF, proportioning systems would need to be added to both ends of the distributed fire main. The system would be designed to discharge water in the sprinkler mode but would switch to AFFF when the valves to the branch lines containing the additional nozzles or monitors are opened.

The previous two approaches can be used to supplement either the automatic (system with thermally activated heads) or deluge sprinkler systems.

B-1.5.3 Alternative Systems for Containing and Combating Fire in the Damaged Area

The two systems described in this paragraph could be installed as a substitute for the required automatic sprinkler system. Both systems would incorporate a supply main capable of rupture isolation as described in paragraph B-1.5.1. Both systems would also be controlled by the fire detection system installed in the space (required in Chapter 11 of this document or added to control the hardened system). The activation criteria (for the undamaged system) can be selected based on the ambient conditions in the facility and the nature of the hazard. The default can be to activate using 135 degrees F (57 degrees C) intrinsically safe heat detectors. If a more sensitive detection system is required, cross-zoned smoke detectors may be an option. The system would activate when one or a group of detectors are damaged (the detector is in “FAULT”).

B-1.5.3.1 Approach 1: Replace the Sprinkler System with Monitors

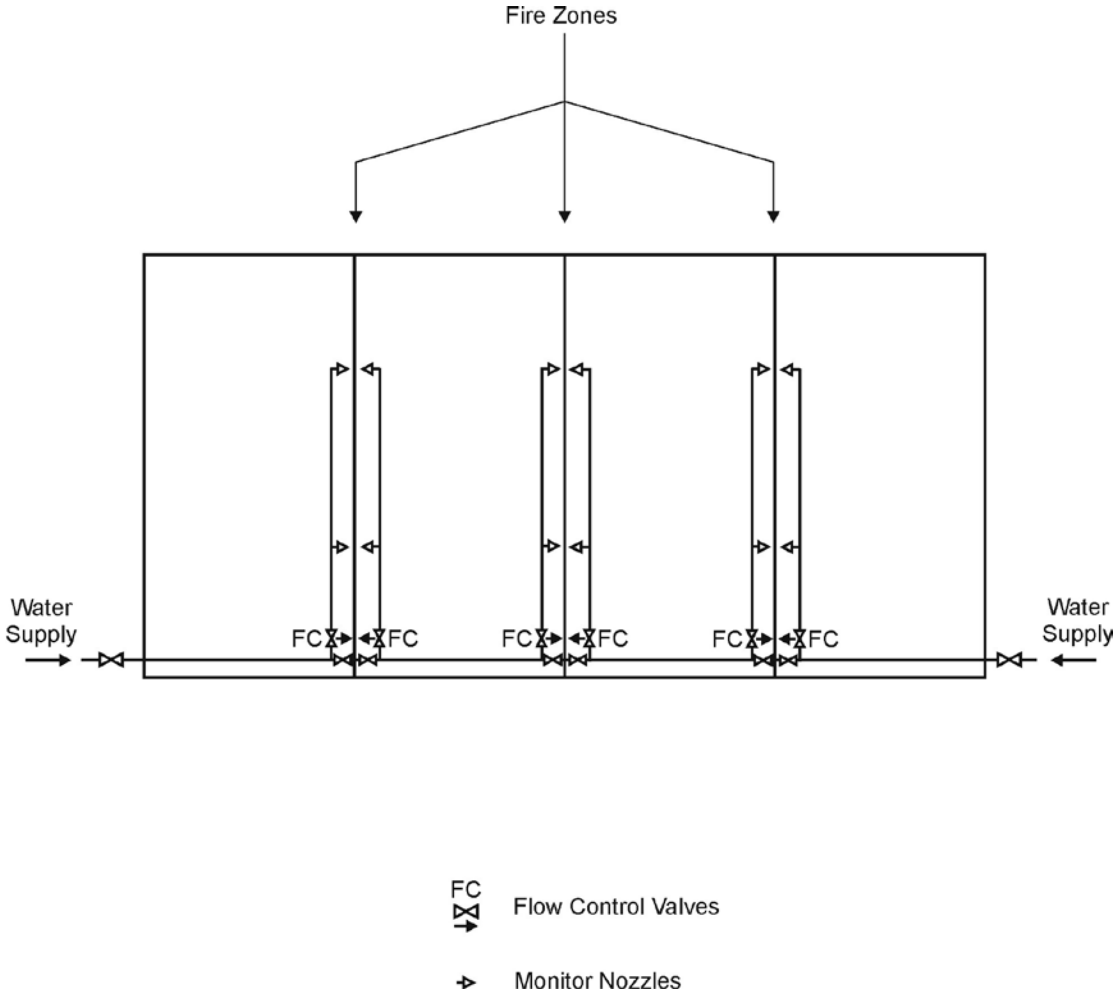
One approach would be to replace the required automatic sprinkler system with one consisting solely of monitors. A system produced using monitors has a better chance of being survivable due to the stream reach characteristics of the device (i.e., the monitor can be located away from the damage) and the reduced amount of piping (no overhead nozzle grid). The system will be designed to provide the same application density (water flow rate per unit area) as the automatic sprinkler system being replaced. In addition, the system would be sized for the simultaneous discharge of the two largest fire zones. An example of a system with monitors is shown in Figure B-4.

B-1.5.3.1.1 Configuration

As shown in Figure B-4, the monitors are located outside of the zone they are protecting. If the damaged area or zone is separated from the adjacent zone by a wall, the monitors would be installed in the boundary, spraying into the damaged area.

Each zone contains two monitors (or more, depending on the size of the zone) located adjacent to the protected area. This approach can work only if there is an uncluttered and unobstructed space for the monitors to be installed with direct coverage of the protected area. The branch line containing the monitors would be equipped with an electrically operated valve controlled by the installed fire detection system. The monitors would be set to automatically oscillate through the protected zone (bounded by limit switches).

Figure B-4 System Consisting of Monitors



B-1.5.3.1.2 AFFF Capability

Since water has only limited capabilities against a potential Class B fire, the system would also be capable of discharging AFFF. To add this capability, proportioning systems would need to be added to both ends of the distributed fire main. The system would be designed to discharge water when the detectors go into ALARM but would switch to AFFF when the detectors have been damaged (show a “FAULT”). This system

is a cost-effective option that provides protection against an incipient-type fire as well as more damaging incidents.

B-1.5.3.1.3 Disadvantages

The primary disadvantage of the system is that monitors require more maintenance than a fixed overhead nozzle grid. There is also a greater chance of “false positive” actuations, i.e., operation of the fire suppression system due to a false detection signal.

B-1.5.3.2 Approach 2: Replace the Sprinkler System with High-Expansion Foam

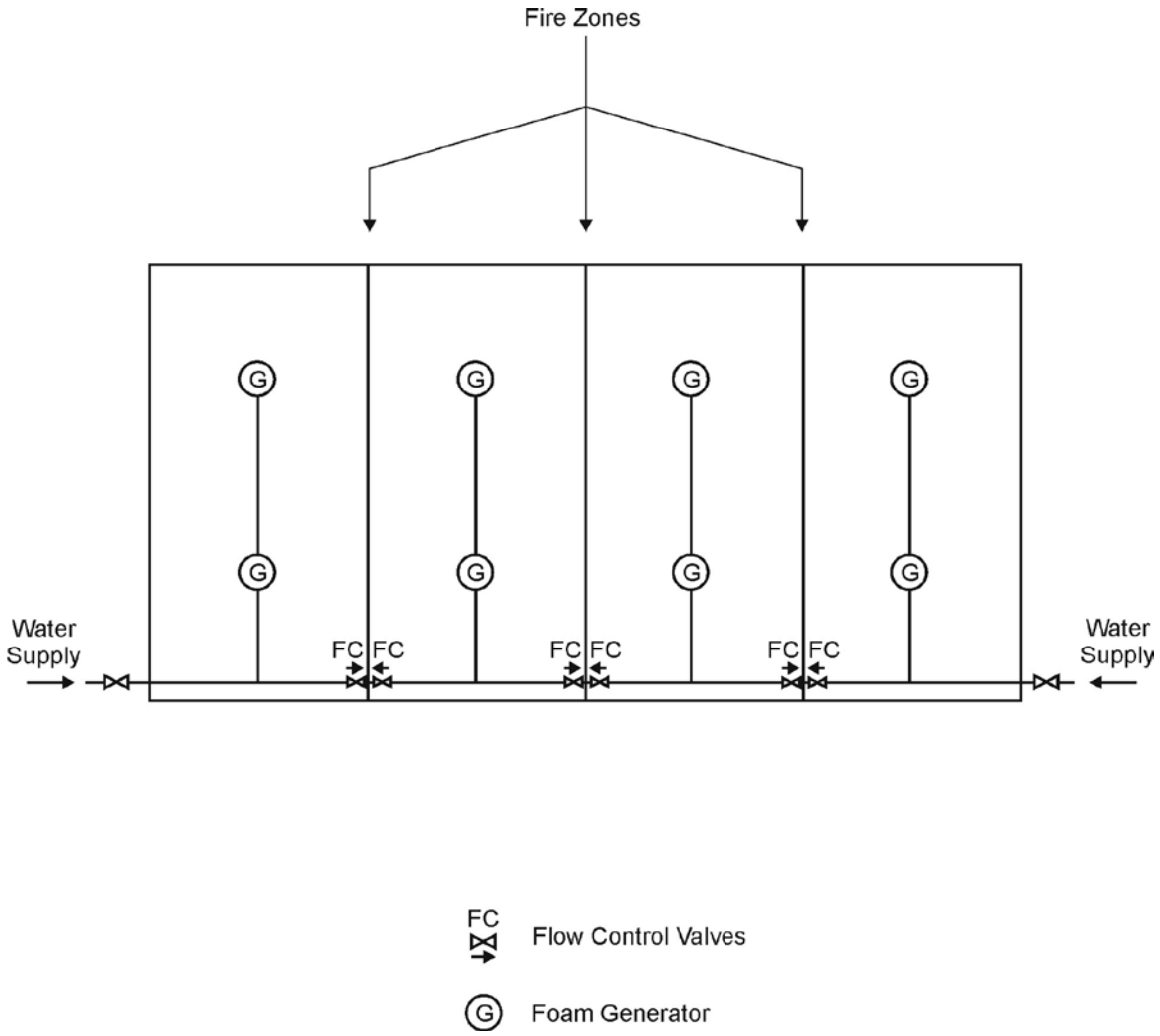
A significantly different approach would be to replace the automatic sprinkler system with a high-expansion foam system. A high-expansion foam system has potentially better capabilities in a damage scenario than an automatic sprinkler system. This is primarily due to the flow characteristics of the foam, i.e., foam would flow from adjacent zones through any penetrations into the damaged area. Another significant advantage of the system is that it has good capabilities against Class B fires. Automatic sprinkler systems have very limited capabilities against Class B fires. The disadvantage of high-expansion foam is that the system needs to be designed to fill the entire enclosure, i.e., high-expansion foam systems can be zoned properly only if the zones are separated by physical barriers to confine the foam in the protected area. Discharging foam throughout the entire area is a major disadvantage for the system during an inadvertent activation or during a smaller, incipient fire scenario (due to clean-up and potential collateral damage issues).

B-1.5.3.2.1 Requirements

The system would be designed to meet the requirements of NFPA 11. For large, open areas or facilities, the system would be designed to uniformly discharge foam throughout the entire area containing the ordnance; however, the system architecture would be designed with zones—but only for rupture isolation purposes because the rupture isolation would allow the undamaged generators in the space to operate properly. For facilities that have fire zones segregated by walls, the system would be designed similar to the system containing monitors, with the foam generators installed in the adjacent zone spraying through the fire zone boundary into the damaged area or zone.

NFPA 11 requires that the system fill the enclosure to a minimum depth of 10 percent above the height of the highest combustible material or 2 feet (0.6 meter) above the highest combustible, whichever is greater. This must occur in a specified maximum time period ranging from two to eight minutes, depending on the type of construction, the presence of an automatic sprinkler system, and the type of materials stored in the space. For this application, it is recommended that the system fill the space to the required depth in less than two minutes. The concentrate and water supplies should have a minimum capacity of 15 minutes. An example of a high-expansion foam system for a large, open area or facility is shown in Figure B-5.

Figure B-5 Example High-Expansion Foam System



B-1.5.3.2.2 Configuration

As shown in this figure, the system supply lines or mains are similar to the automatic sprinkler system described in paragraph B-1.5.1. As with the automatic sprinkler system, the system would be supplied from opposite ends of the facility. A bladder tank proportioning system would be required at both supply points (not shown in the drawing). Rupture isolation is accomplished using flow control valves located on both sides of each fire zone boundary. Mechanical excess flow valves are recommended for this application (most cost-effective and simplest to install).

Due to the simple architecture of the system, only two control valves are required (one at each end of the system). Both valves would be activated by the fire detection system in the event of a fire. Any damaged piping would automatically be isolated and foam would flow from the remaining generators in the space.

B-1.6 SUMMARY AND CONCLUSIONS

The performance objectives of the system will dictate the required architecture. The systems with the greatest capabilities would be the most complex and expensive. Conversely, systems with reduced capabilities would be the simplest and most economical to design and install.

B-1.6.1 Simplest Approach

Maintaining the capabilities of the water-based fire suppression system in the undamaged area is the first step in preventing significant fire spread to adjacent areas. The suppression system must be segregated into fire zones (referred to in this appendix as fire areas). A reliable water supply must be provided. The easiest approach is to supply the system with redundant water supplies at opposite ends of the facility. Rupture isolation must also be provided. Rupture isolation can be accomplished using flow control valves located on both sides of each fire zone boundary. Mechanical excess flow valves are recommended for this application because these valves are the most cost-effective and simplest to install.

In this design, the adjacent zones have no capabilities against the fire in the damaged area. To combat the fire in the damaged area, the suppression system would need to be modified to include additional nozzles, or a new or different system would need to be considered.

B-1.6.2 More Complex Approaches

Modifying the existing sprinkler system or selecting a new system for this application would result in a more sophisticated and complex system than the conventional automatic sprinkler systems commonly in use. Specifically, these modified or new systems would need to be controlled by a separate detection and control system. The fire detection system required in Chapter 11 of this document can be used to control this more sophisticated system, minimizing the cost to obtain these additional capabilities.

Alternative modifications, such as installing additional nozzles or monitors in the adjacent zones that project into the damaged area, would increase the capabilities of the existing system in the damaged area. A line of nozzles similar to a “deck edge”-type system but installed high in the space could be used for this application. Another approach would be to install monitors that automatically oscillate through the damaged area. The monitors would need to be located at a place that is least likely to be obstructed by the contents in the space for the system to be effective and reliable. For these two systems to be effective against a potential Class B fire, the systems would need to be capable of discharging AFFF.

Two less conventional systems have the capability to combat the ensuing fire in a damage scenario: a system consisting solely of monitors and a high-expansion foam system. Monitors can be located outside the zone they are protecting, allowing the system to maintain some capabilities in the damaged area. To be effective against a

potential Class B fire, the system consisting of monitors would need to be capable of discharging AFFF. High-expansion foam has good capabilities against Class B fires and would flow foam into the damaged areas from adjacent zones. High-expansion foam has the disadvantage of needing to fill the entire open area. (High-expansion foam can be zoned only if the protected area is bounded by physical barriers). Either system could be used as a substitute for an automatic sprinkler system.

APPENDIX C GLOSSARY

C-1 ACRONYMS

AE	ammunition and explosive
AF/A4SN	Headquarters Air Force Security Forces, Nuclear Security Division
AFCEC	Air Force Civil Engineer Center
AFCEC/COS	Air Force Civil Engineer Center, Engineer
AFFF	aqueous film-forming foam
AFGSC	Air Force Global Strike Command
AFI	Air Force instruction
AFMAN	Air Force manual
AFNWC	Air Force Nuclear Weapons Center
AFPD	Air Force policy directive
AFSEC	Air Force Safety Center
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATS	automatic transfer switch
Btu/lb	British thermal units per pound
C	Celsius
CB	chemical-biological
CBR	chemical-biological-radiological
DDESB	Department of Defense Explosives Safety Board
DoD	Department of Defense
DoDD	Department of Defense directive
DoDI	Department of Defense instruction
DoDM	Department of Defense manual

DOE	Department of Energy
ECM	earth-covered magazine
EED	electro-explosive device
EFS	essential facility systems
EIS	Engineering Installation Squadron
EMR	electromagnetic radiation
EMRE	electromagnetic radiation environment
ETL	Engineering Technical Letter
F	Fahrenheit
FC	Facilities Criteria
FHA	fire hazard analysis
ft^2	square foot
gpm/ft^2	gallons per minute per square foot
HEPA	high efficiency particulate air
HVAC	heating, ventilation, and air conditioning
IBC	International Building Code
IEEE	Institute of Electrical and Electronics Engineers
kJ/kg	kilojoules per kilogram
LPS	lightning protection system
m^2	square meter
MCFL	maximum credible fire loss
MCE	maximum credible event
MIC	microbiologically induced corrosion
MIL-STD	Military Standard
mm/min	millimeters per minute

MNS	mass notification system
MPFL	maximum possible fire loss
NFPA	National Fire Protection Association
OS&Y	outside screw and yoke
P.E.	professional engineer
SCBA	self-contained breathing apparatus
SFPE	Society of Fire Protection Engineers
STS	stockpile-to-target sequence
UFC	Unified Facilities Criteria
UL	Underwriters Laboratories, Inc.
UPS	uninterruptable power supply

C-2 DEFINITION OF TERMS

Area of Refuge: A room or space that is designated, marked, and suitably equipped to provide a temporary place of safety for building occupants while awaiting rescue during a fire emergency.

Characterization: The process that includes the following: testing and analyzing a facility to determine the effectiveness of a Faraday shield (also known as low impedance testing); electrically bonding metallic penetrations to the Faraday shield; installing appropriate surge suppression; and establishing a reduced safe separation distance (SSD) based on specific test results and analyses.

Combustible: Capable of undergoing combustion.

Combustible Liquid: A liquid that has a closed-cup flash point at or above 100 degrees F (37.8 degrees C).

Criticality: The state of sustaining a chain reaction, as in a nuclear reactor.

Criticality Incident: An accidental, self-sustained nuclear fission chain reaction.

Defense in Depth: A principle aimed at providing a high degree of fire protection by achieving a balance of preventing fires from starting; detecting fires quickly and suppressing those fires that occur, thereby limiting damage; and designing a nuclear facility to limit the loss of life, property, and environment to fire and to ensure continuity of facility operation and safety.

Deflagration: Propagation of a combustible zone at a velocity that is less than the speed of sound in the unreacted medium.

Detonation: Propagation of a combustion zone at a velocity that is greater than the speed of sound in the unreacted medium.

Electromagnetic Radiation (EMR): EMR is a ubiquitous phenomenon that takes the form of self-propagating waves in a vacuum or in matter. It consists of electric and magnetic field components that oscillate in phase perpendicular to each other and perpendicular to the direction of energy propagation. Electromagnetic radiation is classified into several types according to the frequency of its wave; these types include (in order of increasing frequency and decreasing wavelength) radio waves, microwaves, terahertz radiation, infrared radiation, visible light, ultraviolet radiation, X-rays, and gamma rays.

Fire Area: An area that is physically separated from other areas by space, barriers, walls, or other means to contain fire within that area.

Fire Barrier: A continuous vertical or horizontal construction assembly designed and constructed to limit the spread of heat and fire and to restrict the movement of smoke.

Fire Door: A door assembly rated in accordance with NFPA 252 and installed in accordance with NFPA 80.

Fire Hazard Analysis (FHA): An analysis that evaluates potential fire hazards and appropriate fire protection systems and features to mitigate the effects of fire in any area.

Fire Model: Mathematical prediction of fire growth, environmental conditions, and potential effects on structures, systems, or components based on the conservation equations or empirical data.

Fire Prevention: Measures directed toward avoiding the inception of fire.

Fire Protection: Methods of providing fire detection, control, and extinguishment.

Fire-Rated Cables: Cables with an hourly fire resistance rating based on maintaining functionality when exposed to the fire tests in NFPA 251.

Fire-Rated Internal Seal: A conduit seal that is a tested and approved hourly rated fire seal in accordance with ASTM E814.

Fire-Rated Penetration Seal: An assembly provided in a fire barrier opening for the passage of pipes, cable trays, and so forth, to maintain the fire resistance rating of the fire barrier.

Fire-Resistant Hydraulic Fluid: A listed hydraulic fluid or lubricant that is difficult to ignite due to its high fire point and auto-ignition temperature and that does not sustain combustion due to its low heat of combustion.

Fire Resistance Rating: The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as established in accordance with an approved test procedure appropriate for the component under consideration.

Flame Spread Rating: A relative measurement of the surface burning characteristics of building materials when tested in accordance with NFPA 255.

Flammable Liquid: A liquid that has a closed-cup flash point that is below 100 degrees F (37.8 degrees C) and a maximum vapor pressure of 40 pounds per square inch absolute (psia) (2,069 Torr) at 100 degrees F (37.8 degrees C).

Hot Work: Any temporary operation involving open flames or producing heat or sparks, including brazing, cutting, grinding, soldering, arc or gas welding, plasma welding, or torch-applied roofing. Cutting and grinding classified as hot work is limited to operations that produce significant sources of heat or spraying sparks such that they are considered ignition sources to surrounding combustible materials.

Hot Work Permit: A daily or weekly authorization document provided by the fire department for performing hot work outside of an established permissible welding area.

Limited Access Facility: A structure or portions of a structure lacking emergency openings (see NFPA 101).

Limited-Combustible: A building construction material not complying with the definition of noncombustible material that, in the form in which it is used, has a potential heat value not exceeding 3,500 Btu/lb (8,141 kJ/kg) where tested in accordance with NFPA 259 and complies with (a) or (b) below. Materials subject to increase in combustibility or flame spread index beyond the limits herein established through the effects of age, moisture, or other atmospheric condition will be considered combustible. (a) Materials having a structural base of noncombustible material, with a surfacing not exceeding a thickness of 1/8 inch (3.2 millimeters) that has a flame spread index not greater than 50. (b) Materials, in the form and thickness used, other than as described in (a), having neither a flame spread index greater than 25 nor evidence of continued progressive combustion and of such composition that surfaces that would be exposed by cutting through the material on any plane would have neither a flame spread index greater than 25 nor evidence of continued progressive combustion.

Mass Notification System (MNS): A system that provides real-time information to all building occupants or personnel in the immediate vicinity of the building during emergency situations.

Maximum Credible Fire Loss (MCFL): A worst-case fire scenario in which all installed fire protection features operate as designed.

Maximum Possible Fire Loss (MPFL): A worst-case fire scenario in which all fire protection features are not operable and the fire is involved within the entire fire area that is bounded by not less than 3-hour fire barrier walls.

Noncombustible: Not capable of supporting combustion.

National Consensus Standards: Standards, such as those by NFPA, that are consensus by preparation and approval, based on a very specific set of regulations. Generally, these standards are only mandatory when adopted.

Nationally Recognized Testing Laboratory (NRTL): A laboratory that provides fire testing and labeling services to list or approve products. Generally, such laboratories are certified by a national laboratory certification agency.

Occupancy: The purpose for which a building or portion thereof is used or intended to be used.

Radiation: The emission and propagation of energy through matter or space by means of electromagnetic disturbances that display both wave-like and particle-like behavior.

Radioactivity: The spontaneous decay or disintegration of an unstable atomic nucleus accompanied by the emission of radiation.

Redundant Component, System, or Subsystem: A component, system, or subsystem that independently duplicates the essential function of another component, system, or subsystem.

Self-Contained Breathing Apparatus (SCBA): An approved device that provides the user with a safe supply of breathing air via a compressed air cylinder, positive pressure regulator, and full-face mask. The air supply is generally for 30 to 45 minutes.

Through-Penetration Firestop: A tested, fire-rated construction consisting of the materials that fill the openings through the wall or floor around penetrating items such as cables, cable trays, conduits, ducts, and pipes, and their means of support to prevent the spread of fire.

Underground Facility: A structure or portions of a structure in which the floor level is below the level of exit discharge (see NFPA 101).