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D40GEN ADMINISTRATION AND GENERAL REQUIREMENTS

New in this revision (older revisions addressed in Subsection 16, History)

Renamed D40GEN. Moved fire alarm, fire suppression, and testing and commissioning to separate documents.
Changed LANL Fire Protection Group (ES-FP) to LANL Fire Protection (FP) Office. Described FP functions as they relate to projects. Clarified use of Uniform Mechanical Code (UMC) and National Fire Protection Association (NFPA) 90A in lieu of the International Mechanical Code (IMC) for fire protection requirements of mechanical systems.
Expanded highly protected risk (HPR) section including list of characteristics that would increase level of HPR fire protection.
Removed material regarding construction and opening protection that is already in codes and standards.
Expanded Section 5.0, Fire Protection Analysis and Design Documentation:

- Includes criteria and requirements for fire protection design analysis (FPDA), fire hazard analysis (FHA), fire hazard evaluation (FHE), and dust hazard analysis (DHA) documents. Provided content expectations for FPDAs, life safety plans, site compliance plans, and code summary sheets. Expanded and clarified discipline by discipline Main Design (Title II expectation for content of drawings) in bulleted lists.

Added requirements for automatic lighting controls for code compliance. Created a construction section to address NFPA 241 and IFC Ch. 33. Added requirements for two-way emergency communication systems for accessible means of egress (areas of refuge). Added DOE-STD-1066-2016 water supply requirements and provided fire flow and sprinkler system demand criteria for expansion/upgrades to the LANL water distribution system. Added International Fire Code (IFC) as an applicable code in hazmat and special hazard sections. Incorporated D4030 Fire Protection Specialties as a subsection to D40GEN.

Please contact the Fire Standards Engineering Standards Manual (ESM) POC for interpretation, variance, and upkeep issues.

D40GEN GENERAL FIRE PROTECTION REQUIREMENTS

NOTE: This chapter's requirements have been numbered (e.g., Requirement 2-00XX appears after a paragraph). A separate document for Los Alamos National Laboratory (LANL) internal use captures and categorizes the basis for each (available on Chapter 2 webpage).

1.0 SCOPE AND ADMINISTRATION

1.1 General

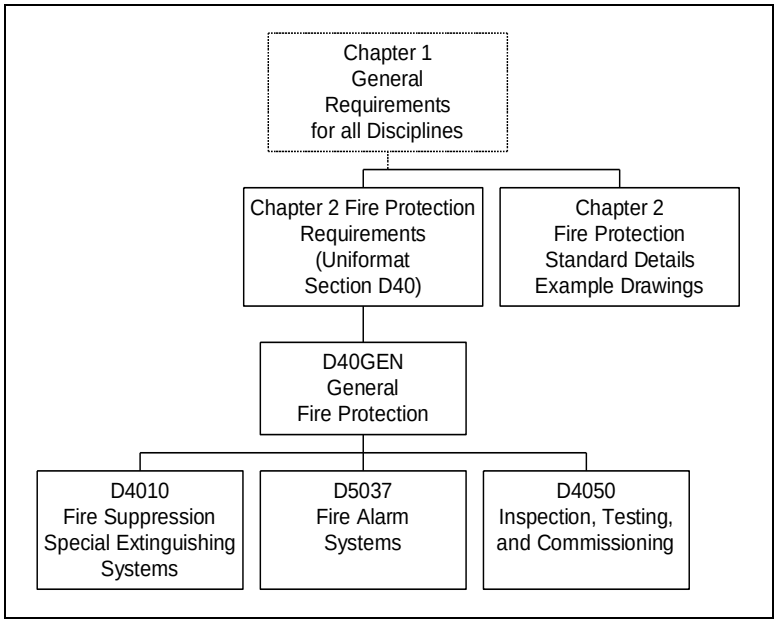
A. The purpose of this chapter of the Engineering Standards Manual (ESM) is to provide requirements for the design and construction of facilities to provide a reasonable level of life safety and a high level of property protection from the risk of fire, explosion, or dangerous conditions.

B. Additional requirements above the minimum code requirements are provided for fire protection and life safety systems to ensure they are efficient, convenient, and adequate for good service and are maintainable, standardized, and adequate for future expansion.

C. This chapter does not document all possible requirements and criteria for projects, including when to provide automatic sprinklers. Projects may have specific design inputs relating to fire protection or life safety. Additionally, the designer is responsible for reviewing and implementing the requirements of applicable codes and standards.

D. All fire protection design, material, equipment, and installations shall comply with requirements in this chapter of the ESM and others as applicable, most notably Chapter 1, *General* (especially Sections Z10 and 200) and Chapter 16, Building Code Program.

E. The hierarchy and the organization of this chapter and its relationships to others is depicted below:



F. Automatic Sprinklers: Section D40GEN provides general fire protection requirements and guidance. Follow Section D4010 for sprinkler piping systems and specialties downstream of the base of the riser, including the riser backflow preventer.

G. Follow ESM Chapter 3, Civil, for requirements upstream of the base of the riser, such as fire hydrants, post indicator valves, and piping. Cross-connection requirements are in ESM Chapter 6 Mechanical.

H. Fire Alarm: Section D40GEN provides general fire protection requirements and guidance. Follow Section D5037 for fire alarm, fire detection, and interfaced emergency control functions.

I. Refer to Section D4050 and ESM Chapter 15, *Commissioning*, for expectations for testing and commissioning of fire protection systems and life safety features.

1.2 Applicability

A. The construction and design provisions of this chapter shall apply to:

1. Facilities planned after the adoption of the official release of this revision of this chapter.

2. Existing facilities repaired, altered, or modified with respect to use, occupancy, or hazard. Application will be modified based on allowances and exceptions provided in the applicable codes and standards, and the judgement of the LANL Fire Protection Office.[1]

3. Existing facilities where specific requirements are listed as retroactively applicable.

1.3 Administration (Guidance)

A. The LANL fire marshal within the Fire Protection (FP) Office is the fire code official for the International Fire Code (IFC), authority having jurisdiction (AHJ) for National Fire Protection Association (NFPA) codes and standards, and Safety Management Program owner (SMPO) for the LANL Fire Protection Program. The LANL fire marshal (FP-AHJ) is delegated by the Head of the National Nuclear Security Administration (NNSA) Los Alamos Field Office (NA-LA).

B. FP performs the following functions in the planning, design, construction, and turnover of facilities:

1. General

a. Administration and enforcement the fire codes.

b. Review and approval of facility designs and equipment specifications.

c. Review and approval of acceptance test procedures.

d. Witness and approval of acceptance testing.

e. Specification of compensatory measures for outages and impairments.

f. Permitting and occupancy.

g. Inspection and approval of construction and modifications to building code requirements.

[1] See also ESM Chapter 16 (e.g., IBC-GEN Att. B, LANL Existing Building Code).

h. Rendering interpretations of codes and standards applicable to fire protection and life safety to clarify the application of its provisions.

i. Interfacing with the Los Alamos Field Office for resolution and approval of code conflicts, equivalencies, and exemptions.

2. Planning and Design

a. Determination of the level of fire protection required above code minimum—based on this chapter, highly protected risk (HPR) criteria, and project fire protection objectives.

b. Review of planning and requirements documents for accuracy and incorporation of applicable fire protection criteria and sufficient level of fire protection.

c. Review of conceptual and main design packages for accuracy, code compliance, and incorporation of fire protection criteria.

d. Review and approval of fire protection design analyses (FPDAs), project/ preliminary fire hazard analyses (pFHAs), and fire hazard evaluations (FHEs).

e. Determination of the requirements for features relevant to fire department emergency operations.

3. Construction

a. Review of construction submittals and deferred designs (shop drawings) for code compliance, coordination between systems, and achievement of required fire protection objectives and design criteria.

b. Review of fire alarm shop drawings (detailed designs in Title II or Title III services) for code compliance, constructability, maintainability, standardization, and technical accuracy.

c. Review and approval of requests for non-emergency use of fire hydrants.

d. Review and approval of outage requests.

e. Reporting utility and system impairments and outages impacting fire department emergency operations to LAFD.

f. Review and approval of exemptions to Stage III fire restrictions.

g. Quality control review of fire alarm system site-specific software programming.

h. Development of and modification to head-end accounts at the LANL proprietary supervising station for fire alarm system remote monitoring.

i. Support of commissioning and integrated testing activities for life safety and fire protection systems.

j. Inspection of facility construction for compliance with life safety and fire protection requirements within division of responsibility.

4. Turn-Over and Certificate of Occupancy

a. Inspection and witnessing of final acceptance testing of fire protection, fire alarm, and life safety systems (within division of responsibility).

b. Support and witnessing of pre-final and final testing of fire alarm systems in verification of remote monitoring.

c. Pre-certificate-of-occupancy inspection to confirm all aspects of building or work area conform with all life safety and fire protection requirements.

d. Inspection and approval for certificate of occupancy as delegated LANL Building Official (LBO) for life safety and fire protection.

e. Coordination of LAFD tours for new or significantly modified facilities for awareness and pre-incident planning (PIP).

2.0 ACRONYMS AND DEFINITIONS

Refer to ESM Chapter 1, Section Z10, for any not listed below (and CoE glossary, when issued).

Title	Description
AHJ	Authority having jurisdiction. The Los Alamos National Laboratory (LANL) fire marshal is the AHJ and owner of this ESM chapter; however, engineering standard-related inquiries can be initially directed to the Standards Program Fire POC.
Design Agency	The organization performing the detailed design and/or analysis of a project or modification (see ESM Chapter 1, Section Z10).
Design Authority	The person or group responsible for the final acceptability of and changes to the design of a system or component and its technical baseline. This is typically the manager of Engineering Services, but the AHJ in the case of Chapter 2 (See PD340).
DACT	Digital alarm communicator transmitter
EOC	Emergency Operations Center
ESM	Engineering Standards Manual (LANL)
FM	Factory Mutual
FP	Fire Protection Office at LANL (or fire protection, in the general sense)
HPR	Highly protected risk
IBC	International Building Code
IFC	International Fire Code
ITM	Inspection, testing, and maintenance
LAFD	Los Alamos Fire Department
LANL	Los Alamos National Laboratory
NFPA	National Fire Protection Association
NRTL	Nationally Recognized Testing Laboratory
STR	Subcontractor Technical Representative
UL	Underwriters Laboratories

3.0 CODES AND STANDARDS

3.1 General

A. Engineering Standards Manual (ESM) Chapter 1, Section Z10, addresses some of the required codes, standards, Code of Federal Regulations (CFR), and LANL Engineering Standards. It also addresses how these codes and standards and the ESM are to be

applied, including topics such as precedence of documents, clarifications and variances, code of record, design output requirements, and environmental qualification of equipment.

B. Above and beyond the requirements of Z10, the LANL fire marshal, in addition to the chapter POC, must approve any amendments (clarifications, variations) to this chapter (Requirement 2-0001).

3.2 DOE (Department of Energy)

Comply with the following:

A. DOE O 420.1, *Facility Safety,* version per ESM Chapter 1, Section Z10, and NNSA/LANL contract (*ref. Att. 2 Chapter II in latest Rev. C Chg. 3)* (Requirement 2-0002),

B. DOE-STD-1212, *Explosives Safety,* 2019 (later edition when adopted by P101-8*, Explosive Safety (latest is here)* (Requirement 2-0003), and

C. DOE-STD-1066-2016, *Fire Protection* (use latest *[2023]* edition when adopted by PD1220, *Fire Protection Program*) (Requirement 2-0004).

3.3 Building and Mechanical Codes

A. Comply with the International Building Code (IBC), International Existing Building Code (IEBC), and the International Fire Code (IFC) (Requirement 2-0005).

1. Follow ESM Chapter 16 (*Building Code Program Section IBC-GEN, App A, LANL Building Code*) for LANL-required editions and amendments.
2. Refer to the following sections of ESM Chapter 5, *Structural*, for seismic design/analysis provisions:
   a. Section I for DOE natural phenomena hazard mitigation requirements and designated seismic systems.
   b. Section II for commercial/non-nuclear applications.
   c. Section III for nuclear applications.

B. Follow the most stringent fire and life safety requirements of the IBC, IFC, and NFPA 101 Life Safety Code[2], and New Mexico and LANL (*IBC-GEN Att. A)* amendments to these mandates (Requirement 2-0006), in accordance with ESM Chapter 1, Section Z10 precedence requirements.

1. This will meet the life safety requirements of Occupational Safety and Health Administration (OSHA) (29 CFR 1910) and worker safety and health expectations of 10 CFR 851 (Requirement 2-0258).
2. The LANL fire marshal is the authority having jurisdiction (AHJ) for resolving conflict regarding what requirement is most stringent and any mutually exclusive conflicts among these documents, contacting the Los Alamos Field Office when necessary (Requirement 2-0007).
3. Where the above codes refer to AHJ or the administration authority for Fire Protection matters, refer to the LANL fire marshal.

[2] Per ESM Chapter 1, Section Z10, subsection on Codes and Standards (driven by NSEP-TP-1).

C. Comply with the fire protection requirements of the Uniform Mechanical Code (UMC) and NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, instead of those in the IBC and International Mechanical Code (IMC)[3] (Requirement 2-0218). Key differences include:

1. Criteria for installing duct smoke detectors in the supply or return air of air handling units.
2. Installation of fire dampers rather than combination fire-smoke dampers for the protection of duct openings in shafts.

3.4 Factory Mutual Insurance Company (FM Global)

A. FM Global Property Loss Prevention Data Sheets shall be applied where specifically referenced by DOE-STD-1066 and this chapter (Requirement 2-0010).

B. Other FM data sheets shall be used as guidance when applying highly protected risk (HPR) criteria with a graded approach, in whole or in part, as warranted by the hazard and loss potential.

C. Current data sheets are available at: www.fmglobal.com/research-and-resources/fm-global-data-sheets.

D. *AXA XL Property Risk Consulting Guidelines is another helpful resource for implementing risk averse HPR criteria to critical infrastructure and important facilities.*

3.5 National Fire Protection Association (NFPA)

A. NFPA codes and standards (Requirement 2-0011).

1. Refer to Attachment 1 of this document for LANL-required editions and exceptions.

B. *A current list of NFPA codes and standards is available at:* www.nfpa.org*. LANL users have access here and non-LANL users may register for the free* viewer*.*

Guidance: Refer to the Fire Protection Handbook and other guides.

3.6 Society of Fire Protection Engineers

Guidance: Handbook of Fire Protection Engineering, 5th Edition.

4.0 GENERAL REQUIREMENTS

4.1 Project Conceptual Design Considerations *(Guidance)*

A. Developing an effective fire protection design and maintaining an effective fire protection program at a new or modified facility requires consideration of a variety of fire protection topics at an early stage of any project. These considerations should be continually revisited throughout the project with increasing attention to detail until the project is completed. These project considerations may impact vital fire protection program elements through the useful life of the affected facility, and will have lasting impact after a facility construction project has been turned over for operations.

[3] For separation of occupancies, sleeping areas, and hazards. There is no NFPA/UMC requirement; it may be more appropriate to apply the IBC requirements to achieve an IBC-specific fire protection objective.

B. Below is a brief list of project-related fire protection considerations. Many of these are addressed in this chapter or other chapters of the ESM. However, the expertise of a fire protection engineering professional is vital to ensure that all relevant project aspects have been appropriately considered.

1. Site and Civil Considerations: emergency vehicle and emergency responder notification/response time, proximity/availability and condition of firefighting water including fire hydrants, nearby hazards to emergency responders, emergency responder access, emergency responder pre-incident planning, emergency responder facility familiarity training, contaminated water runoff containment or mitigation.
2. Operations Considerations: material hazards, materials storage, process hazards, process utilities, operations procedures and training, facility safety analysis expectations.
3. Architectural Considerations: size, occupancy, construction materials, construction techniques, emergency egress, exposure hazards, security considerations, fire separation between areas.
4. Structural Considerations: construction materials, fireproofing of structural elements, deflagration venting, flood/seismic/snow/wind design.
5. Mechanical, Instrumentation and Controls Considerations: fire protection water supply, piped fire protection systems, pneumatic power and control systems, piped gasses, HVAC systems, smoke control and smoke management.
6. Electrical Considerations: system controls, detection and alarm, emergency lighting, primary and backup power, lighting protection, need for electrical equipment rated for hazardous locations.
7. Maintenance Considerations: equipment accessibility, frequency, and methodology of required inspection, testing, and maintenance (ITM), special equipment required to perform ITM.

4.2 Highly Protected Risk (HPR)

A. Highly protected risk or improved risk is a class of industrial loss prevention criteria to address special or severe hazards and the potential for significant property loss. LANL adopts a comprehensive management approach to this, consistent with property insurance industry expectations that result in preferred insurance premium status. The design and construction elements of HPR include:

1. Substantial facility construction (e.g., fire-resistive, and non-combustible), including interior fire-rated barriers and protection of openings, segregation of hazards, and fire protection systems.
2. Adequate (of sufficient capacity and duration) and reliable fire protection water supplies.
3. Automatic sprinkler protection or alternative suppression where necessary.
4. Proper protection of special hazards, including special extinguishing systems where appropriate, protection of process hazards, and protection of special occupancy hazards.
5. Supervision of facilities, including remote monitoring of fire protection systems.
6. Control of and protection from severe fire exposures, including the aggregation of hazards posed by multiple tenants within a single facility, adjacent facilities, relocatable/temporary structures, and wildland fire.

The implementation of HPR is project-, operations-, and facility-specific.

B. DOE-STD-1066 defines the minimum requirements for DOE HPR criteria, including following FM Global Datasheets when required or recommended. A graded approach is allowed in the application of appropriate requirements, which are more stringent than national codes and standards.

C. HPR levels of fire protection shall be provided for LANL facilities, at a minimum complying with DOE-STD-1066 requirements and recommendations (Requirement 2-0008).

This chapter provides only the lowest level of HPR fire protection for all facility projects, based on the requirements and recommendations of DOE-STD-1066. For example, most commercial construction does not require automatic sprinklers, but these systems are required at LANL for facilities that are greater than 5,000 sq ft or $5.9M (2018 dollars) of maximum possible fire loss. This is one of the base HPR criterion for facilities included in DOE-STD-1066-2016. Facility projects require analysis to properly implement the recommendations of DOE-STD-1066-2016 and identify possible risks and additional required features.

D. The LANL fire marshal is the HPR criteria AHJ, determining the level of fire protection required to meet the intent of DOE-STD-1066 (Requirement 2-0009).

E. Projects shall document the HPR criteria for the facility or facility modification in the project planning and design documentation, including elements and criteria listed in Part A and F. (Requirement 2-0219).

F. HPR fire protection is enhanced, on a graded approach based on risk, where the facility:

1. Could be expected to change to a more hazardous operation or occupancy.
2. Has unique equipment or operations or potential fire scenario that is not adequately addressed by ICC or NFPA codes and standards.
3. Poses an unacceptable exposure hazard fire to surrounding facilities or spaces.
4. Is high value, difficult to replace, or provides a vital function.
5. Is mission essential, mission critical, or anticipated to have a high mission dependency index (MDI[4]).
6. Has a fire hazard analysis (FHA) requiring additional fire protection features.
7. Will be impacting a planned future facility that will require increases levels of fire protection.
8. There are other fire risks to property not adequately addressed.

4.3 General Building Construction Requirements

A. Fire resistance ratings for buildings shall be based on the IBC and NFPA 101 requirements for occupancy type, size, number of floors, adjacent exposures—whichever is more restrictive (must evaluate both) (Requirement 2-0012).

B. Minimum construction for LANL facilities, greater than 5,000 sq ft in gross area, shall be IBC Type II-B or NFPA 220 Type II (000) (Requirement 2-0013).

C. The use of Type III, IV, or V construction types for facilities less than 5,000 sq ft in gross area requires approval of the LANL fire marshal (Requirement 2-0014).

[4] Certain high MDI scores may drive the facility to ML-3. Ref. LANL SD330 and AP-341-502.

D. Hazard Category 1, 2, or 3 nuclear facilities shall be a minimum construction of IBC Type II-B or NFPA 220 Type II (000) (Requirement 2-0015).

4.4 Fire Barriers

A. Fire barriers and associated ratings shall be indicated on drawings to support ongoing inspection and maintenance and to support future modification work. (Requirement 2-0018)

B. Additional requirements for fire barriers:

1. If fire areas are used to minimize potential property loss or mission continuity loss in a structure, barriers shall have a fire rating of no less than two hours, unless justified by the fire hazard analysis (Requirement 2-0020).
2. If fire barriers are used to segregate or minimize large (i.e., greater than $412 million baselined at CY2018 values) property loss potentials within a structure, barriers shall have a fire rating of no less than three hours, unless justified by the fire hazard analysis (Requirement 2-0021).
3. Provide a fire-rated barrier when identified by a hazards analysis as needed to minimize the consequences of a fire within or outside of a facility (Requirement 2-0024).

4.5 Fire Barrier Penetrations, Openings, and Joints

A. When a fire barrier is required for any reason, it shall be maintained in good condition for the lifetime of the facility (Requirement 2-0025).

B. Penetrations, openings, and joints in a fire barrier shall be protected with materials, assemblies, or devices to maintain the fire barrier rating (Requirement 2-0026).

C. Designs for building modifications involving new penetrations or openings shall indicate ratings of any fire barriers and provide basis-of-design penetration firestop and fire-resistant joint systems (Requirement 2-0027).

D. *Guidance: Project drawings should include a table defining designated fire and smoke barriers including barrier construction material and any tested configuration reference, hourly fire barrier rating or smoke barrier rating, and specific penetrating item or joint the barrier (type, location, size, and penetrating item).* Where a fire door, fire damper, or penetration seal that is not UL/FM approved is to be used in a fire barrier, it shall still be tested to ensure it provides adequate fire protection or it shall be reviewed and accepted by a fire protection engineer in the LANL Fire Protection (FP) Office (Requirement 2-0030).

E. Ventilation Penetrations

1. The design shall support fire damper installation in accordance with manufacturer's instructions, including expansion clearance requirements, detail of rough opening framing, and access details for inspection, testing, and maintenance activities. (Requirement 2-0032).

   Guidance: Also refer to SMACNA Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.
2. Refer to ESM Chapter 6, Subsection D3040 HVAC Distribution, for additional fire and/or smoke damper requirements.

F. Fire Doors

1. Fire doors in high traffic circulation spaces shall be equipped to automatically close in the event of smoke or fire conditions on either side of the barrier. Smoke detectors shall be used for release unless prohibited by environmental conditions (Requirement 2-0036).

G. Other Types of Penetrations

1. Where structural steel penetrates a fire-rated barrier, that configuration shall be reviewed by a fire protection engineer in the LANL FP Office to determine if additional fire protection measures are required (Requirement 2-0038).

5.0 FIRE PROTECTION ANALYSIS AND DESIGN DOCUMENTATION

5.1 General

A. Refer to Section Z10 of LANL ESM Chapter 1 for design output general requirements. This article (5.0) applies to design documentation created under Title II services for construction document (permitting package) production.

B. Preparing structure, system, or component (SSC) drawings. Comply with the LANL CAD Standards Manual and the applicable NFPA code or standard.

C. Seal designs per ESM Chapter 1 Section Z10 (*Design Output Submittals subsection).*

5.2 Fire Protection Engineering Analysis

A. Where any of the following are required, a fire protection engineer[5] (FPE) shall perform or directly oversee the effort (Requirement 2-0223)[6]:

1. A fire protection design analysis (FPDA)
2. A project fire hazard analysis (pFHA)
3. An NFPA 801 fire hazard analysis (801-FHA)
4. A fire hazard evaluation (FHE)
5. A dust hazard analysis (DHA)
6. Commissioning per NFPA 3 (see Section D4050)
7. Integrated system testing per NFPA 4 (see Section D4050).

B. FPDA: A fire protection design analysis is required where any of the following conditions exist (Requirement 2-0224):

1. New facilities exceeding 5,000 sq ft of floor area or a maximum possible fire loss (MPFL) exceeding $5.9 million (in 2018 dollars).
2. Where a modification to an existing facility:
   a. Increases floor area above 5,000 sq ft,
   b. Increases MPFL above $5.9 million (in 2018 dollars),

[5] See DOE-STD-1066-2016 definition of an FPE. Other qualifications or qualified professionals may be acceptable for tasks or deliverables with the approval of the LANL FP Office.
[6] DOE required fire protection engineer (FPE) involvement is performed (through consultation) by the LANL Fire Protection Office (FP) for very minor corrective work and overseen (through review) by FP for minor alterations designed in-house by a knowledgeable person who does not meet the definition of an FPE. Anything more complex requires an FPE outside of FP to perform or oversee the effort. FP's involvement is limited to independent review, interpretation, HPR requirements, and SME direction or guidance.

c. Is classified as an IEBC Level 3 Alteration,

d. Includes an addition greater than 1,500 sq ft, or

e. Includes a change in occupancy to a higher hazard category of occupancy greater than 1,500 sq ft.

3. New facilities or modifications introducing unusual or significant life safety hazards.

   New facilities or modifications introducing high hazard contents, processes, and occupancies *(e.g., Group H occupancy classifications, flammable liquid dipping operations, or high-pile storage areas greater than 500 sq ft).*

4. Where directed by the LANL FP Office.

C. pFHA: A project fire hazard analysis is required for (Requirement 2-0225):

1. HazCat 1, 2, or 3 nuclear facilities (new or major modifications).
2. Facilities representing unique fire safety risks.
3. New or modifications to existing facilities with value greater than $177 million (2018 dollars).
4. When directed by the LANL FP Office.

D. An NFPA 801 FHA (801-FHA) is required for (Requirement 2-0226):

1. New and modified facilities storing, handling, or using radiological materials regulated by NFPA 801 and do not currently have a pFHA or facility fire hazard analysis (FHA).

E. FHE: A fire hazard evaluation is required for (Requirement 2-0227):

1. New and modified gloveboxes containing radioactive materials not addressed by an FHA.

F. DHA: A dust hazard analysis is required for (Requirement 2-0228):

1. All facilities and operations storing, handling, using, or producing combustible dusts per NFPA 652, NFPA 654, or applicable industry-specific NFPA standards.

5.3 Fire Hazard Analysis and Fire Hazard Evaluation

A. Contact the LANL FP Office for content requirements for (Requirement 2-0047):

1. Project fire hazard analysis (pFHA)
2. NFPA 801 fire hazard analysis (801-FHA)
3. Fire hazard evaluation (FHE)

5.4 Fire Protection Design Analysis (FPDA)

The fire protection design analysis (FPDA) is an engineering analysis for non-nuclear facilities during or preceding the preliminary design to establish fire protection design criteria, including applicable national codes and consensus standards. The FPDA shall be developed by, or under the direction of, a fire protection engineer (FPE), subjected to an adequate peer review, and approved through an established process. Updated during the design process, the FPDA provides a comprehensive design review that ensures the fire protection requirements are incorporated into the design.

The FPDA shall include the elements identified below to ensure that the requirements of DOE O 420.1C are incorporated into the design criteria. In accordance with the "graded approach" concept, the level of detail necessary for an acceptable FPDA is based on the complexity of the

facility, the potential risk to the public and facility operators, and property loss potential. (Requirement 2-0229).

A. Building Code Analysis

This element identifies the applicable building codes, standards and determine the Code of Record (COR). DOE O 420.1C, *Facility Safety*, requires that the design and construction of new facilities and major modifications to existing facilities meet codes and standards in effect when the design criteria are approved (i.e., the COR). Applicable codes and standards for design include the provisions of relevant federal regulatory requirements, DOE directives, IBC codes, NFPA, and other national codes and consensus standards in effect when the COR is established during the design phase. As the design matures, specific or additional fire protection design requirements shall be identified and included.

B. Fire Protection and Life Safety Systems

This element describes the fire protection systems, including requirements for automatic sprinklers, alternative automatic suppression fire systems (special hazards), standpipe systems, fire pumps, water supply, portable fire extinguishers, smoke control systems, smoke and heat removal, fire department connections and fire alarms including carbon monoxide detection. Life Safety

C. Means of Egress

This element includes life safety requirements for the occupancy group, such as occupant load, exit capacity, travel distance, exit width, common path of travel, dead-end corridors, use of suites, etc. are identified in accordance with NFPA 101, *Life Safety Code* and the IBC.

D. Features of Fire Protection

Fire areas and other fire separations are identified as required by values according to DOE O 420.1C, such as occupancy groups, control areas, hazards separation, and separation of safety systems. Fire wall and fire barrier fire resistance rating requirements must be identified.

E. Code Compliance and Documentation

Design criteria documents should ensure compliance with the applicable codes and standards identified (e.g., COR). Any changes in the design or construction must be monitored for compliance with the established criteria. Required documents regarding system design and function shall be maintained for the life of the system. Draft analysis of unresolvable deficiencies or code conflicts (IBC versus NFPA), variances, or alternate methods requiring a request for relief (field office disposition, or equivalency or exemption request) must be approved and documented.

F. Also include:

1. Life safety plans
2. Site compliance plans
3. Code compliance summary sheet
4. Preliminary hydraulic analysis

5.5 Main Design Drawings

Provide main design drawing packages documenting and incorporating fire protection requirements in the ESM, codes, and standards project-specific design input. The design drawings,

in combination with the calculations and construction specifications, shall provide a clear description of the work to be performed and the compliance of the completed work (Requirements 2-0047 and -0048).

Design drawings should not be confused with shop drawings (i.e., working drawings) required by NFPA standards and produced by the fire protection vendor and installer, and provided as part of a submittal during construction. The design details below cannot be delegated or deferred to fire protection vendors or installers.

Include the following as they apply and to the level required by the project scope, with the design features documented in the appropriate discipline sheet for the trade performing the work. When in doubt, contact the LANL FP Office.

A. Provide a **code compliance summary** sheet including the following fire protection analysis (Requirement 2-0047):

1. Provide a summary of the building code and life safety code analyses results from the FPDA or pFHA.
2. Specifically call out any approved or submitted code conflict resolutions, equivalencies, and exemptions.
3. If an FPDA or pFHA is not required, at a minimum consider the information under ESM*, Architectural*, Section B-C GEN General Architectural (*Article 7.3 Project Design Data)*.
    a. Additionally, relevant fire protection criteria and requirements shall be documented and compared with the features and capabilities to be provided by the project or modified by the project.
    b. The level of detail may be commensurate with the level of alteration or scope of the project, but at a minimum, identify the codes of record and applicable standards, the occupancy classification (IBC and NFPA), and level of alteration (IEBC) and classification of rehabilitation work category (NFPA 101).

B. Provide **life safety** plans including the following minimum fire protection analysis (Requirement 2-0048):

1. Capacity and number of occupants using each major means of egress component (e.g., stairs, stair doors, exterior doors, assembly exit doors).
2. Maximum travel distance, dead-end corridors, common path of travel, accessible means of egress, and exit components for each floor and occupancy classification. When suites are used, indicate type, location, area, and arrangement.
3. IBC and NFPA occupancy classification of each room, area, or compartment (on the drawings or in tabular form). Include occupant load of each room, area, or compartment. Similar occupancies can be grouped together for occupant load calculations.
4. Location and rating of all fire walls, fire barriers, fire partitions, smoke barriers, and smoke partitions (both horizontal and vertical). Barriers requiring fire resistance rated supporting construction must be specifically identified for coordination with the structural design.
5. Location of hazardous materials storage, handling, and use that exceed the maximum allowable quantities.
6. Structural fireproofing locations and associated ratings.

7. Location, type, class, and capacity of fire extinguishers.

C. Provide **site compliance** plans including the following minimum fire protection analysis (Requirement 2-0047):

1. Line of encroachment identifying assumed lot lines and minimum separation distances from adjacent buildings, structures, and other exposures.
2. Building perimeter used for frontage increases.
3. Fire department access.
4. Fire lane width, marking and locations, approach roads, and turn radius and location.
5. Swept path (e.g., AutoTURN) analysis, where performed.
6. Type of access control security.
7. Intended fire department main entrance to facility.
8. Location of Knox Boxes.
9. Location of fire department connections and test headers.
10. Fire hydrants, post indicator valve or valves, and their connected water distribution mains serving facility.
11. Fire pump rooms.
12. Water storage tanks.
13. Hazardous material spill and potentially contaminated fire suppression water containment.
14. Backflow prevention assembly or assemblies serving water-based fire protection systems (if located outside of building).

D. Provide **civil** drawings showing:

1. Fire department access roadways.
2. Fire lane striping and signs.
3. Underground utilities—especially water distribution, fire hydrants, and post-indicator valves.
4. Installation details for hydrants, post-indicator valves, bollards, and other features.
5. Exterior collection basins for contaminated water.
6. Tree thinning and vegetation mitigation.
7. Pedestrian walkways, ramps, and stairs from the exit discharge to the public way.
8. Transformers, aboveground storage tanks, generators, and other equipment.

E. Provide **structural** drawings showing:

1. Location of fire-rated structural members, load-bearing walls, and horizontal assemblies.
2. Fire-rating analysis or listed system of fire-rated bearing walls, floors, and roofs.
3. Fire walls and high challenge fire walls.
4. Coordination of structural members with architectural features.
5. Slab openings coordinated with locations of shafts, vertical openings, and fire damper sizes.

F. Provide **architectural** drawings showing:

1. Location and types of partitions with details of fire and smoke resistance and protecting of openings (doors, windows, joints, penetrations, etc.)
2. Type of ceiling construction and elevations.
3. Wall, ceiling, and floor finishes.
4. Materials of construction indicated in sections and details.
5. Details of concealed spaces and openings between occupied and unoccupied spaces.
6. Details of floor transitions and thresholds.
7. Plans, sections, and details for stairs and ramps, guards, and handrails.
8. Door and hardware types and schedules.
9. Window/glazing details.
10. Firestopping and fire-resistant joint details (if not provided elsewhere).

G. Provide **mechanical** drawings showing:

1. Fire and smoke damper locations and details (coordinated with fire alarm).
2. Dust smoke detector locations (coordinated with fire alarm).
3. Air velocity indicated at dynamic dampers and duct smoke detectors.
4. Smoke control system component location, details, and sequence of operation (coordinate with fire alarm).
5. Firestopping details for penetrations (if not provided elsewhere).

H. Provide **electrical** drawings showing:

1. Location of normal and emergency lighting (including exterior).
2. Automatic lighting controls, control zones, and schedules.
3. Location of exit signs.
4. Locations of conduit penetrations and recessed electrical boxes in fire-rated or smoke-rated walls, floors, ceilings, and other assemblies.
5. Dedicated circuits for fire alarm and fire protection systems and features.
6. Convenience receptables and manual transfer switches at fire alarm control panels and notification appliance power panels.
7. Firestopping details for penetrations (if not provided elsewhere).

I. Provide **controls** drawings showing:

1. Interfaces and sequence of operations with fire alarm, smoke control, and other fire protection systems.

J. Provide **network/telecommunications** drawings showing:

1. Locations of conduit penetrations and recessed electrical boxes in fire-rated or smoke-rated walls, floors, ceilings, and other assemblies.
2. Locations of telecom and network tie-in for fire alarm, elevator communication, area of refuge two-way emergency communication, and other life safety and fire protection systems.

K. Provide preliminary **fire suppression** drawings and details that adequately communicate the desired fire protection/suppression design and its required performance (Requirement 2-0049).

Guidance: Projects must be clear whether fire suppression drawings are preliminary for engineering or detailed for installation (shop drawings). Modifying an existing building fire suppression system will require determining the existing system performance criteria.

1. Based on project details, indicate project-specific fire protection/suppression criteria, including occupancy (hazard) classifications and high-rack storage commodity classes.
2. Provide plan view drawings showing:
    a. Requirement for automatic sprinkler, standpipe, or special hazard extinguishing system.
    b. Type of system, hazard classification, and protected area.
    c. Results of preliminary hydraulic analysis.
    d. Location of risers, isolation valves, test headers, and backflow preventers.
    e. Locations of mains where necessary to coordinate utility conflicts.
    f. Zoning (e.g., per floor and/or fire area).
    g. Areas exempt from sprinkler protection.
    h. Special types of sprinklers.
    i. Devices to be supervised by the fire alarm system.
    j. Special features and obstructions impacting sprinkler system.
    k. Project-specific design constraints.
3. Provide section views to indicate ceiling types and configuration and to support shop drawing preparation.
4. Provide riser diagrams to indicate arrangement of multi-floor and multi-zone systems.
5. For modifications or additions to existing systems, provide drawings and details of the existing system to indicate hydraulic remoteness from the system control riser and support hydraulic calculations.
6. Follow Chapter 2, Section D4010, for fire suppression system requirements.
7. Per NFPA 13 requirements for shop drawings, detailed system working drawings shall be provided if the work will not be subcontracted to a fire sprinkler vendor to develop (i.e., LANL internal design self-perform). See Chapter 2, Section D4010.

L. Provide preliminary **fire alarm** drawings and details that adequately communicate the desired fire alarm design and its required performance (Requirement 2-0050).

Guidance: Projects must be clear whether fire alarm drawings are preliminary or detailed (shop drawings). Modifying an existing building fire alarm system will require obtaining and revising the fire alarm record (as-built) drawing—in either Title II or Title III—and an FP review by a fire protection engineer and a fire alarm specialist.

1. Provide plan view drawings showing:
   a. Location and identification of fire alarm control panels, notification appliance booster panels, amplifiers, and annunciator panels.
   b. All interfaced, interconnected, and integrated systems and emergency control functions.
   c. Areas to be provided with occupant notification (audible, visual, or both).
   d. Expected average and peak ambient sound pressure levels.
   e. Required alarm sound pressure levels.
   f. Areas to be provided with automatic fire detection and the type provided.
   g. Locations for manual alarm pull stations.
   h. Sufficient building detail to support preparation of working plans of the fire alarm system, including wall types, ceiling heights, and structural details.
2. Provide section drawings to indicate ceiling type and configuration when necessary to support working (shop) drawing preparation or design and layout of detection systems.
3. Provide riser diagrams to indicate configuration and segmentation of circuits throughout the facility.
4. Provide project-specific performance requirements regarding:
   a. zoning (with separate circuits or isolation modules),
   b. circuit class,
   c. survivability level,
   d. number and location of panels, and
   e. other project-specific requirements.
5. For modifications or additions to existing systems, provide drawings and details of the existing system to indicate relation to existing portions and support calculations.
6. Provide an input/output matrix to describe the required functional performance of the fire alarm system and its interfaced systems and emergency control functions.
7. Provide detailed design documentation regarding specialized detection systems, risk analyses, and performance-based detection or notification.
8. Follow Chapter 2, Section D5037 for fire alarm system requirements.
9. System layout and detailed design per NFPA 72 for shop drawings shall be provided if the work will not be subcontracted to a fire alarm vendor to develop (i.e., LANL internal design self-perform). See Chapter 2, Section D5037.
10. A complete fire alarm system shop drawing package shall be provided for review of new systems and modifications to existing systems. Partial drawing sets will not be accepted.

5.6 Calculations

A. Provide a preliminary hydraulic analysis, including hydraulic calculations for new or modified portions of the water supply distribution system. LANL will provide hydrant flow

test data to support the effort. Also see Chapter 3, Section G30, *Site Civil/Mechanical Utilities* for additional requirements (Requirement 2-0041).

Guidance: Calculation methods are presented in the relevant NFPA standards (e.g., 22, 24) and the NFPA Handbook. For hydraulic calculations associated with nuclear facility sprinkler systems, consult with the design authority to identify additional requirements, if any.

B. Provide **preliminary hydraulic calculations** for fire suppression systems to be installed or modified in the facility. Calculations are to provide supporting evidence that the proposed fire suppression system demands can be adequately supplied as well as the means required to provide it (e.g., fire pumps, looped mains, larger orifice sprinkler heads, or other special system configurations) (Requirement 2-0042).

1. Calculation methods are presented in relevant NFPA codes (e.g., 13, 14), and software to conduct the calculations in accordance with these methods is available.
2. Determine the hazard classification based on the information provided in the Requirements and Criteria Document (RCD), applicable codes and standards, and other design input documents.
3. Refer to Section D4010 for hydraulic calculation requirements for fire suppression (e.g., automatic sprinkler) shop drawings *(typically provided in Title III for new facilities and Title II for facility alterations).*
4. Hydraulic calculations shall be provided for modifications to existing systems that do not match the same piping configuration (e.g., tree, side-side, looped, or gridded), pipe sizes for mains and branch lines, and number and arrangement of sprinkler heads in the piping network.

   An exception is where the modification is excluded from the hydraulic calculation per NFPA 13 (e.g., small closets and single heads under obstructions).
5. One or more proposed design areas for hydraulically remote portions of the new or modified facilities or facility additions shall be calculated. Where the margin between supply and demand is less than 20 pounds-per-square-inch (psi) for an estimated demand, a prototypic design area, mains, and riser shall be hydraulically calculated to confirm adequate supply.

Guidance: For hydraulic calculations associated with nuclear facility sprinkler systems, consult with the design authority to identify any additional requirements.

C. Based on the occupancy classification and use of the space(s), provide occupant loads and egress capacities along the means of egress in the area of project work and beyond, depending on the potential impact. Both the IBC and NFPA 101 methods and requirements shall be followed (Requirement 2-0043).

D. Provide preliminary fire alarm system calculations (audibility, voltage drop, battery load calculations) where a new fire alarm system is designed or an existing system is modified, as required, to provide design direction to the fire alarm vendor. Determine the need and location of remote fire alarm control panels or notification appliance booster panels, the need to increase the size of batteries, and the need to provide additional fire alarm control panel cards or auxiliary systems (Requirement 2-0044).

Refer to Section D5037 for associated requirements for fire alarm shop drawings *(typically provided in Title III for new facilities and Title II for facility alterations).*

E. Provide calculations for all special hazard and other fire protection systems, such as clean agent, inert gas, foam, smoke exhaust, and smoke pressurization. (Requirement 2-0045).

Guidance: The level of detail at the design stage is typically to establish feasibility of the approach and locations of major equipment and primary features. If final layout and calculations will be provided by the installation vendor, also determine size and locations of major equipment. Complex systems, such as smoke control, should be fully designed, with supporting calculations, in the building design package.

F. For new or modified roadways, if fire department access roads cannot be provided in strict compliance with this chapter's requirements (*Section 12.0*), provide a swept path analysis based on worst-case responding Los Alamos Fire Department apparatuses to support the roadway and paving design (Requirement 2-0046).

6.0 EQUIPMENT/PIPING IDENTIFICATION

A. See NFPA 13; ESM Chapter 1, Section 200; and Chapter 6 Mechanical, Section D10-30GEN for requirements.

7.0 EXPOSURE AND NATURAL PHENOMENON HAZARDS PROTECTION

A. Adjacent Relocatable Structures: DOE-STD-1066 and NFPA 80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*, shall be used to determine acceptance criteria for separation from permanent structures that might represent exposure hazards (Requirement 2-0051).

B. Separation distance between hazardous equipment and structures: NFPA 30, *Flammable and Combustible Liquid Code*, and other applicable NFPA codes, standards, and recommended practices, such as NFPA 70 and NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines,* shall be used to determine required distances (Requirement 2-0052).

Guidance for hazardous equipment (e.g., oil-filled transformers, diesel generators, etc.): The required separation distance to protect a structure or nearby equipment from adjacent hazardous equipment typically depends on the type and size of the associated fire hazard and on the construction of the building. Also consider the guidance of FM Global Loss Prevention Data Sheets, XL GAPS Guidelines, and other similar insurance industry guidelines, to determine appropriate separation distances and fire protection. Oil runoff issues are also addressed as fire protection concerns in the same data sheet (e.g., oil runoff that exposes a different, unaffiliated structure downhill from a transformer or lack of oil collection resulting in environmental contamination concerns into the soil, into a canyon with wildland fire issues, etc.) The LANL FP Office is available to provide additional guidance.

C. Wildland Fire: NFPA 1144, *Standard for Reducing Structure Ignition Hazards from Wildland Fire*, and the International Wildland-Urban Interface Code (ICC), shall be used to determine how to evaluate the degree of wildland fire hazard for a particular facility. For explosives facilities, use DOE-STD-1212 to determine special requirements for their protection (Requirement 2-0053).

1. As a minimum, a 10-foot-wide space around buildings shall be maintained clear of all trees. In more heavily forested areas, a 50-foot-wide space around buildings shall be maintained clear of trees (several isolated trees may be acceptable), and the next 50 feet beyond shall be thinned. In less heavily forested areas, less

clearing/thinning may be acceptable. Consult the LANL Fire Protection Office for guidance (Requirement 2-0054).

2. *Guidance: Los Alamos County has a dry climate, intense and frequent lightning storms, and steep terrains—all of which contribute to increased wildland fire hazard. NFPA 1144 also provides different strategies that can be used to reduce wildland fire threat, including establishing fire breaks around facilities (by thinning or eliminating vegetation), providing fire resistive construction for new structures, ensuring appropriate roadways for emergency vehicle access, etc.*

D. Lightning: Provide as required per ESM Chapter 7, Section D5090 (Requirement 2-0055).

E. Seismic: Per NFPA 110, paragraph 7.11.6, "… [Emergency power systems, or EPS], transfer switches, distribution panels, circuit breakers, and associated controls shall be capable of performing their intended function during and after being subjected to the anticipated seismic shock." (Requirement 2-0057)

1. As such, these items, as applicable to a given project, are designated seismic systems (DSS). Refer to ESM Chapter 5, Section I (*article* 1.7) for details pertaining to design and documentation requirements for DSS. Also, DSS that are active or have active components are subject to special inspection and testing as described in Chapter 16, *Building Code Program* (see Section IBC-IP and its Attachment B (SSI) Table 1705.14).

8.0 FIRE PREVENTION FEATURES

A. Fire prevention features shall be part of the project plans and specifications just as fire protection systems are (Requirement 2-0098).

1. **Combustion Safeguards on Fuel-Fired Equipment**. Follow NFPA 85, *Boiler and Combustion Hazards Code,* and NFPA 86, *Standard for Ovens and Furnaces*.
2. **Heating Equipment for Hazardous Areas**. In hazardous (electrically classified) areas, specify heating equipment suitable for these areas. Use indirect fired heating equipment or heat exchangers. Also see NFPA 85.
3. **Electrical Equipment for Hazardous Areas**. Follow NFPA 70, *National Electrical Code;* NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas;* and NFPA 499, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*. Also follow UL/ANSI 913 where applicable.
4. **Laboratories**. Follow NFPA 30 and 45, *Standard on Fire Protection for Laboratories Using Chemicals,* for fire protection requirements applicable to laboratories using chemicals. Note: NFPA 45 does not apply to all laboratories using chemicals. Consult Chapter 1 of NFPA 45 regarding applicability. For laser laboratories and operations, follow NFPA 115.
5. **Diking/Drainage for Liquids**. Design for safe containment of 110 percent of the capacity of the largest tank. Design shall consider diking, diversionary diking, drainage to catch tanks, or drainage to a safe location. Also see the IFC, NFPA 30, NFPA 400, NFPA 801, *Standard for Fire Protection for Facilities Handling Radiological Materials*; and NFPA 15 annex.
6. **Prevention of Potentially Contaminated Firefighting Water Runoff**. Follow NFPA 801 for the design capacity of collection, containment, and/or retention

features. Firefighting water shall include both the anticipated quantity of sprinkler discharge and concurrent manual hose streams deployed by the fire department.

B. Fire prevention best practices shall also be incorporated into the design approach, where indicated by hazard analyses or FP direction (Requirement 2-0099).

1. **Fail-Safe Process Design**. Design process equipment to fail safely. For example, heat sources off, feed valves closed, agitation systems running, cooling water valves open, and ventilation on. Fail-safe settings and the interlocks that occur upon failure of process equipment will vary with every process.
2. **Process Monitoring and Interlocks**. Monitor all parameters of a process that could contribute to fire or explosion. Parameters to be considered include pressure, temperature, flow, concentration, agitation, liquid levels, and positions of doors and dampers.
3. **Programmatic Combustible Loading**. Design buildings and processes to keep combustible loading at the minimum necessary for normal operations.

9.0 CONSTRUCTION

A. **System Outage and Impairment Process**. Follow Criterion 301, *Planned Utility Outage*, and Criterion 733, *Fire Protection System Impairment Control Program*, in the LANL Operations and Maintenance (O&M) Manual (Requirement 2-0100).

B. **Construction Fire Protection Plan**. A fire protection plan shall be provided for construction projects to address the requirements of NFPA 241 and International Fire Code (IFC) Chapter 33 (Requirement 2-0265).

1. The contents of the plan shall address the following items, as applicable:
    a. Long-term impairments to fire protection systems, extent, compensatory measures, and scheduled return to service.
    b. Housekeeping and maintenance of combustible loading.
    c. Temporary heating and electrical power equipment.
    d. Impacts to the means of egress (e.g., closures, obstructions).
    e. Impacts to fire department access roadways and access to fire protection features.
    f. Site laydown, hazardous material storage, and fire exposure to existing structures.
2. A comprehensive plan is required for major projects, such as new facility construction, extensive renovation, and facility demolition.
3. For minor projects, such as Level 1 and Level 2A/B Alterations, only the items relevant to the scope of the project are required to be addressed.
4. Documented plans shall be submitted to LANL FP review for major projects and when requested for minor projects.

10.0 LIFE SAFETY CONSIDERATIONS

10.1 Illumination and Marking of the Means of Egress

A. Normal illumination, emergency lighting, and marking of the means of egress shall be provided as required by IBC and NFPA 101 (Requirement 2-0103). Refer to the ESM Chapter 7, Electrical, for additional requirements.

Guidance: The designated means of egress will be determined by the LANL FP Office. It typically includes all exit access corridors, stairways, ramps, aisles in large spaces requiring two means of egress (especially assembly occupancies), and other components of the required means of egress. Where supplementary egress paths are provided above the code minimum, these areas may be excluded with the approval of the LANL FP Office.

B. Where an automatic lighting control system turns off or dims lights below 1 foot-candle in the designated means of egress, the system shall comply with the follow requirements (Requirement 2-0230):

1. Listed lighting controllers shall be provided.
2. Devices provided as part of the system to override automatic lighting dimming/switching controls for emergency lighting equipment shall be appropriately listed.

   Guidance: For example, use UL 924 *for automatic load control relays, directly controlled luminaries, and external bypass controls; UL 1008 for branch circuit emergency lighting transfer switches.*
3. The minimum lighting levels in the designated means of egress and designated stairs shall be maintained for at least 15 minutes after vacancy of the floor served or floors served, respectively.
4. In areas where lighting is initially illuminated to less than full output either through manual input or automatic controls, the lighting may be initially dimmed to no less than 50 percent of full output and shall be above 1 foot-candle in the path of egress.
5. Automatic lighting controls shall not reduce the illumination levels below 1 foot-candle (by dimming or turning off lights) in the designated means of egress when any spaces served are occupied.
6. The requirements to maintain or automatically restore illumination to the designated means of egress is permitted to apply to only a portion of a floor or building constituting the required means of egress.
7. Compliant lighting levels shall be restored when the building fire alarm system, where provided, activates a general alarm and evacuation.
8. Lights that are required to remain illuminated for photoluminescent exit signs shall not be automatically turned off or dimmed below minimum required levels when the building is occupied.
9. Power for charging batteries for emergency lights and exit signs shall not be turned off by the lighting controller.

C. Automatic controls that do not reduce the lighting levels in designated means of egress below 1 foot-candle need not comply with Paragraph B above (Requirement 2-0230).

D. Automatic lighting controls configured to dim or turn off lights in the designated means of egress to levels for which a single failure (e.g., loss of a lamp or luminary) would reduce

lighting levels below 0.2 foot-candle at any point shall comply with Section 10.1.B (Requirement 2-0230).

Guidance: As a simplification to lighting design, it is recommended that lights along the designated means of egress should not be automatically turned off but instead automatically dimmed to a low level that exceeds the minimum illumination requirements.

It would also be permitted for this function to be coupled with a lighting schedule to allow automatic off after business hours. If this is combined with restricted access control and occupant load limits after-hours, fire alarm tie-in would not be required. Continuous illumination is a required condition for general occupancy of the building.

10.2 Two-Way (Area of Refuge) Emergency Communication Systems

A. A two-way emergency communication system (ECS) shall be provided where required for the accessible means of egress (e.g., elevator lobby, area of refuge, exterior area for rescue assistance) per the IBC, NFPA 101, or other codes.

B. In addition to the requirements of NFPA 101 and the IBC, the two-way ECS shall comply with the requirements of NFPA 72, Section 24.10 (Requirement 2-0231). This includes:

1. Remote communication devices (call boxes) shall automatically connect to a central control point (master or lobby phone) inside the building or complex of buildings.
2. Where the central control point is not at a constantly attended location, the central control point shall automatically dial out to 9-1-1 and not the EOC.
3. Remote communication devices shall provide both audible and visible indicators to show that communication has occurred and indicate to the receiver the location sending the signal.
4. The two-way ECS shall supervise the integrity of power supplies and wiring between the central control point and remote communication devices.
5. Remotely monitor supervisory signals via the building fire alarm system and digital alarm communicator transmitter (DACT) reporting to the LANL proprietary supervising station. See D5037.

11.0 PRE-EMERGENCY PLANNING PROGRAMS

A. Coordinate with LANL Fire Protection (FP) Office to provide documentation to the Los Alamos Fire Department (LAFD) describing a new facility or changes to an existing facility so that the pre-incident plans can be kept up to date. Provide documentation and coordinate facility walkthroughs once construction is substantially complete and in advance of requesting the certificate of occupancy (Requirement 2-0104).

Guidance: The Los Alamos Fire Department develops and maintains pre-incident plans for important LANL facilities to aid firefighters in responding to a facility fire.

Guidance: Generic guidance on fire water runoff is somewhat addressed in DOE-STD-1066 (¶ 4.2.5.4 in 2012), and NFPA 801, Standard for Fire Protection for Facilities Handling Radioactive Materials, § 5.10 Drainage. The DOE has also issued a draft document, Guidance for Estimating Fire Suppression System Runoff Volume in DOE Nuclear and Hazardous Substance Locations. Additionally, the pre-incident plans for each facility address some aspects of firewater runoff. Where there is no specific requirement for fire protection water runoff control at a facility (i.e., required by a documented safety

analysis), the facility must monitor firefighting water runoff and will be required to clean up any resulting contamination. Ensure that Facility Management is aware when a design change might affect fire protection-related water runoff.

B. Coordinate with LANL FP Office and/or Emergency Management Division (EMD)-Emergency Preparedness (EP) to provide up-to-date information on any changes to an existing facility's physical hazards or hazard configuration, so that pre-incident plans and emergency planning can be updated. Provide documentation and coordinate facility walkthroughs once construction is substantially complete and in advance of requesting the certificate of occupancy (Requirement 2-0105).

C. For new or significantly modified facilities, especially those with an emergency planning hazards assessment (EPHA), coordinate with the LAFD through FP and the FOD to ensure that LAFD personnel are provided with appropriate tours (Requirement 2-0106).

Guidance: Firefighters may encounter a variety of different physical hazards at LANL facilities, including radiological, chemical, cryogen, or laser.

D. Evacuation plans/diagrams, in accordance with the CAD Standards Manual, STD-342-300, are required in each facility at LANL, unless specifically exempted by FP and the FOD. When facility configurations are changed, the evacuation plans shall also be changed. Coordinate with Facility Management for evacuation plans/diagrams. Coordinate with EMD-EP for emergency plans/procedures (Requirement 2-0107).

12.0 SITE FIRE DEPARTMENT ACCESS

A. Provide fire department access roads to buildings, fire hydrants, fire department connections, and related equipment in accordance with NFPA 1, *Fire Code*, the IFC, and the applicable standards (e.g., NFPA 13, 14, 20, and 24) (Requirement 2-0108).

B. The LANL fire marshal has the authority to modify requirements for fire department access roads for buildings and structures that do not present a significant fire hazard, loss potential, interruption, or impact to DOE programs, fire exposure to other facilities, or impact to safety, the public, or environment (Requirement 2-0109).

C. Plans for paved, temporary, and alternative surface (other than concrete or asphalt) shall be submitted to the LANL FP Office for approval prior to installation (Requirement 2-0110).

1. Alternative surface fire lanes shall be designed by a professional engineer registered in the state of New Mexico (Requirement 2-0111).

D. LANL-specific design criteria are as follows. Fire department access roads shall:

1. Have a minimum inside turning radius of 30 feet and a minimum outside turning radius of 50 feet (Requirement 2-0112); and

2. Be designed to support a fire apparatus with a total weight of 83,500 pounds and an axle weight of 63,000 pounds (Requirement 2-0113).

E. The LANL fire marshal may permit hose lay distances to be increased from the IFC required 150 feet up to 450 feet for facilities protected with automatic sprinklers or with other mitigating factors (Requirement 2-0114).

F. Fire department access roads shall be marked as fire lanes (Requirement 2-0115):

1. within vehicle parking lots,

2. along alleys or roadways that are not designated or marked as a LANL street or road,
3. within 15 feet of a fire hydrant or fire department connection; and
4. when determined necessary by the LANL fire marshal to identify their location, prevent their obstruction, or prevent obstruction of fire protection equipment.

G. Fire lanes shall be marked on both sides—unless permitted otherwise—with signs, curb markings, road surface markings, or a combination thereof as follows (Requirement 2-0116):

1. Signs shall be metal construction, 12 inches wide by 18 inches high, reflective, with red lettering on a white background. Signs shall read one of the following:

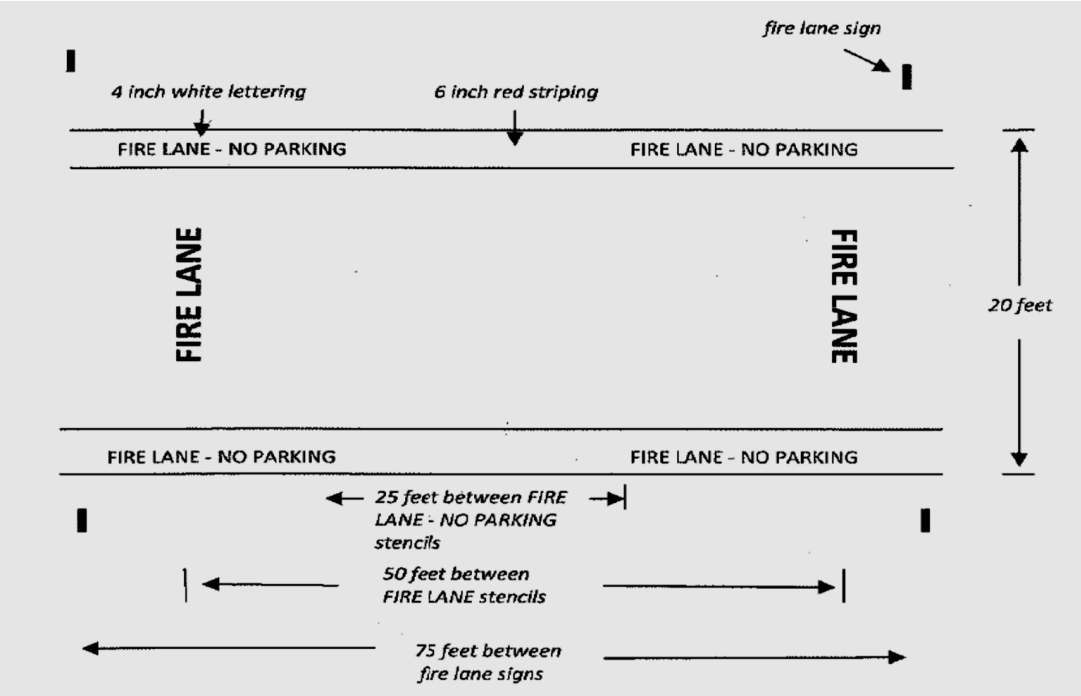
   a. FIRE LANE – NO PARKING

   b. NO PARKING – FIRE LANE

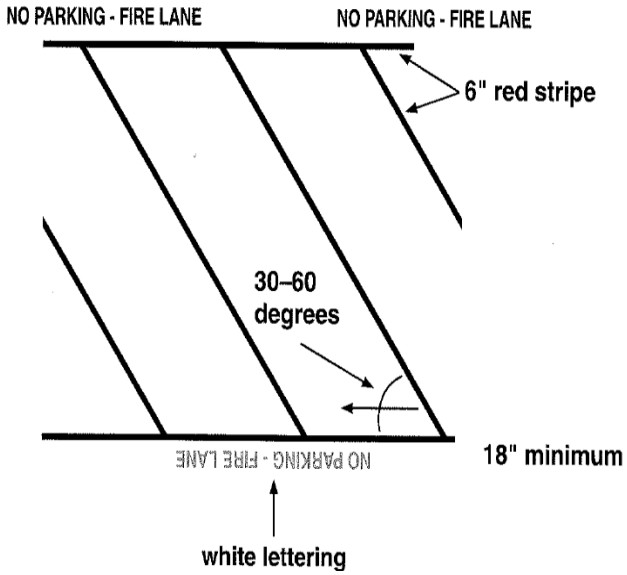
   Signs shall be mounted 7 feet above the road surface, at both ends of the fire lane, and at a maximum 50-foot interval. The interval may be increased to 75 feet when combined with curb or roadway markings.

2. Curbs shall be painted red along the entire length with "FIRE LANE – NO PARKING" in 4-inch high, white letters at a 25-foot maximum interval.
3. Road surface markings shall consist of "FIRE LANE – NO PARKING" in 4-inch, white letters inside the stripe at a 25-foot maximum interval along the edge of the road. This shall be supplemented with either:

   Option 1: 6-inch-wide red stripes along the edges of the roadway and collinear with the letters. In the roadway "FIRE LANE" in 10-inch high, red or white letters marked at 50-foot intervals, and oriented to be read from the direction of fire department arrival as shown immediately below.



Option 2: Letters along edges of the roadway and outlined, diagonal hatching in the roadway between. The outlined, hatching consists of 6-inch red stripes along the edges of the road and diagonal stripes between the edges at 18-inch spacing and angle between 30 and 60 degrees as shown below.



H. The marking of fire lanes shall be subject to approval by the LANL fire marshal. The type of fire lane marking that is advisable is dependent on the type, width, and arrangement of the fire department access road (e.g., parking lot with or without islands versus roadways with or without curbs), factors contributing to obstruction of the roadway (e.g., location of nearby loading docks and equipment rooms) availability of parking, expectations for snow clearing, and maintainability (Requirement 2-0117).

13.0 SITE FIRE PROTECTION WATER DISTRIBUTION

A. Refer to the General Chapter, Section Z10, Subsection Z1020, and the Civil Chapter, Subsection G3010, for site requirements.

B. To assure a reliable water distribution system for fire protection water, the follow criteria shall apply for modifications, extensions, and new systems (Requirement 2-0232):

1. The existing water distribution system shall provide an adequate water supply to support a two-hour duration of the most hydraulically demanding sprinkler system, a concurrent 500-gpm hose allowance, and the average domestic and process demands—except for dedicated fire protection water systems.

2. A 250-gpm hose allowance is permitted for portions of the water distribution serving only non-nuclear facilities with sprinkler system designs not exceeding that of Ordinary Hazard Group 1.

3. Configuration of the water distribution system shall provide redundant flow paths where service mains supply more than five fire hydrants or three facilities with fire suppression systems, unless otherwise approved by the Fire Protection Office.

4. New and upgraded portions of the water distribution system supplying fire protection water should assume (for planning purposes) the following minimum demand criteria occurring non-concurrently, unless determined to be greater or directed otherwise by the LANL FP Office:

a. Minimum manual fire flow in mains feeding fire hydrant: 1,500 gpm at 20 psi.

b. Minimum sprinkler system demand: 600 gpm at 85 psi base of system riser plus 500 gpm at nearest hydrant.

C. For the construction of new facilities in existing/established areas, modification of existing water distribution, new fire or domestic lead-ins, and similar alterations is not required to supply the demands listed in 4.a and 4.b. Instead, see Part B.1. and B.2. above.

D. Hazard Category 1, 2, or 3 Nuclear Facilities: Refer to DOE-STD-1066 Appendix A for design, material, construction, quality assurance, and inspection, testing, and maintenance (ITM) requirements associated with safety significant (SS) and safety class (SC) fire protection water supplies (Requirement 2-0118).

Guidance: The LANL combined fire protection and potable (i.e., domestic) water supply distribution system is considered to operate as a public utility. NFPA 24 is not applicable to these portions of the water supply distribution system, including the fire hydrants supplied by the system. The standard is applicable to the lead-in to the automatic sprinkler or standpipe riser and distribution systems solely for the purposes of providing fire protection water to risers and/or fire hydrants. Dedicated fire protection water distribution systems are found at TA-35, LANSCE, and TA-55, among others.

14.0 SPECIAL FIRE/EXPLOSION HAZARDS

A. Special fire and explosion hazards include the following (Requirement 2-0119):

1. **Warehousing and Storage.** Follow the IFC and NFPA 1. Automatic fire detection or sprinkler systems shall be provided for high-pile and high-hazard storage. At a minimum, automatic sprinkler systems shall comply with the

requirements of NFPA 13. For unique storage arrangements not addressed by NFPA 13, comply with the applicable FM Global Datasheet for the configuration.

2. **Gloveboxes, Hot Cells, and Filter Plenums.** Follow DOE-STD-1066, *Fire Protection;* NFPA 801; AGS-G010, *Standard for Practice for Glovebox Fire Protection;* and DOE-HDBK-1081, *Primer on Spontaneous Heating and Pyrophoricity.* Also follow NFPA codes relevant to the hazard including NFPA 30, NFPA 45, and NFPA 318, *Standard for the Protection of Semiconductor Fabrication Facilities*.

   Guidance: The requirements for fire protection within gloveboxes and similar experimental or process enclosures, including fire extinguishing or fixed inerting systems, shall be determined and documented within a fire hazards evaluation (FHE) prepared in accordance with NFPA 801 and AGS G010 (consult with the LANL FP Office for FHE requirements).

3. **Hazardous Materials.** Follow the IFC, NFPA 1, and the applicable NFPA standards, including NFPA 30 for flammable and combustible liquids, NFPA 55 for compressed gases and cryogenic fluids, NFPA 400 for hazardous materials, NFPA 484 for combustible metals, and NFPA 652 and other industry-specific standards for hazardous dusts (see NFPA 1 Ch. 40 for requirements).

4. **Explosive materials.** Follow DOE-STD-1212, *Explosives Safety*, IFC, and NFPA 495, *Explosive Materials Code*. Compliance with the life safety provisions of DOE-STD-1212 does not automatically exempt a facility from also complying with the life safety requirements of NFPA 101 or the IBC.

5. **Paint Spraying/Coating.** Follow the IFC, NFPA 1, NFPA 30, NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials,* and NFPA 34, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids*. Cleaning operations with flammable or combustible liquids are also required to comply with the appropriate application-specific NFPA standard.

6. **Tank Storage of Liquids.** Follow the IFC and NFPA 30. Follow the application-specific NFPA standard for special uses such as fire pump (NFPA 20) and generators (NFPA 37).

7. **Information Technology (IT) Equipment**. Follow NFPA 70. Where necessary based on the risk to life, property, or mission, apply NFPA 75, *Standard for the Fire Protection of Information Technology Equipment*, for computing and data processing occupancies and follow NFPA 76, *Standard for the Fire Protection of Telecommunications Facilities,* for telecommunications occupancies. The presence of IT equipment does not require application of these standards. Typical replacement value threshold is $10 million, but other factors should be considered. Also follow FM Global Datasheet 5-32, *Data Centers and Related Facilities*, for computing and data processing occupancies (Requirement 2-0120).

15.0 FIRE PROTECTION SPECIALTIES

15.1 Portable Fire Extinguishers

A. Fire extinguisher types, locations, and signage shall be in accordance with NFPA 10, *Standard for Portable Fire Extinguishers,* the applicable building and fire codes (i.e., IBC, IFC, NFPA 1, and NFPA 101), and applicable occupancy, equipment, or industry-specific standards (Requirement 2-0151).

B. Information on proposed fire extinguishers shall be reviewed by the project point of contact in the LANL FP Office prior to purchase and installation (Requirement 2-0152).

Guidance: Fire extinguishers are typically furnished by the using group and installed by LANL craft. Alternately, fire extinguishers may be furnished by the project for new facilities.

C. Follow the LANL Master Specification 10 4400, *Fire Protection Specialties* (Requirement 2-0153).

16.0 HISTORY

Rev.	Date	Description	POC	RM
0	6/28/99	Fire Protection requirements from the Architectural and Mechanical Facilities Engineering Standards, Volumes 4 and 6, incorporated into this chapter.	James Gourdoux, *FWO-FP*	Dennis McLain, *FWO-FE*
1	11/18/02	Changed FEM to LEM. Complete revision and addition of endnotes.	Julia Wood, *FWO-FP*	Kurt Beckman, *FWO-SEM*
2	10/27/06	Administrative changes only. Fire Alarm Systems subsection moved from Ch. 7, D5030. Organization and contract reference updates from Los Alamos Nuclear Security (LANS) transition. IMP and ISD number changes based on new Conduct of Engineering IMP 341. Master Specifications number/title updates. Other administrative changes.	Julia Wood, *ER-FP*	Kirk Christensen, *CENG*
3	6/18/08	Added IFC, NM IBC amendments, most stringent concept. Protection loss threshold was $1 million. Occupancy analysis for IBC and NFPA. Added 420.1-3, deleted STD-1062. Other minor changes.	Julia Wood, *EO-FP*	Kirk Christensen, *CENG*
4	11/21/13	Incorporated DOE O 420.1C and DOE-STD-1066-12, commissioning expectations. Resolved PFITS 2011-504 CA2. Other minor changes.	Jim Streit, *FP-DO*	Larry Goen, *ES-DO*
5	4/05/18	Added seismic requirements, need to identify fire barriers on drawings (4.5/6), interfaces to IBC. Implemented PFITS 2013-2393-CA3 regarding mods to listed equipment (at 4.3) and others. Periodic review and update.	Jim Streit, *FP-DO*	Larry Goen, *ES-DO*
6	2/05/21	Updated dollar limits to DOE O 420.1C Chg 3. Invoked DOE-STD-1066-2016. Added NFPA code/standard edition attachment. LANL Fire Protection Division (FP-DO) became LANL Fire Protection Group (ES-FP). Clarified role of the LANL Field Office for code conflicts, equivalencies, and exemptions. Required listed antifreeze to address IM-2019-1083 #7. Added requirements for fire-resistant joints in Part 4.6. Expanded requirements for design documentation for Title II services. Provided guidance when Light Hazard and Ordinary Hazard Group 1 occupancy classifications may be used. Clarified which portions of water supply system to apply NFPA 24. Added local requirements for backflow preventer forward-flow test headers, fire department access roads, and the marking of fire lanes. Added reference to Requirement Log at each requirement. Updated emergency management reference to EMD-EP.	Keenan Dotson, *ES-FP*	Jim Streit, *ES-DO*
7	06/29/23	Renamed D40GEN. Moved fire alarm, fire suppression, and testing and commissioning to separate documents. Changed LANL Fire Protection Group (ES-FP) to LANL Fire Protection (FP) Office. Described FP functions as they relate to projects. Clarified use of Uniform Mechanical Code (UMC) and National Fire Protection Association (NFPA) 90A in lieu of the International Mechanical Code (IMC) for fire protection requirements of mechanical systems.	Keenan Dotson, *FP*	Michael Richardson, *ES-DO*

		Expanded highly protected risk (HPR) section including list of characteristics that would increase level of HPR fire protection. Removed material regarding construction and opening protection that is already in codes and standards. Expanded Section 5.0, Fire Protection Analysis and Design Documentation: Includes criteria and requirements for fire protection design analysis (FPDA), fire hazard analysis (FHA), fire hazard evaluation (FHE), and dust hazard analysis (DHA) documents. Provided content expectations for FPDAs, life safety plans, site compliance plans, and code summary sheets. Expanded and clarified discipline by discipline Main Design (Title II expectation for content of drawings) in bulleted lists. Added requirements for automatic lighting controls for code compliance. Created a construction section to address NFPA 241 and IFC Ch. 33. Added requirements for two-way emergency communication systems for accessible means of egress (areas of refuge). Added DOE-STD-1066-2016 water supply requirements and provided fire flow and sprinkler system demand criteria for expansion/upgrades to the LANL water distribution system. Added International Fire Code (IFC) as an applicable code in hazmat and special hazard sections. Incorporated D4030 Fire Protection Specialties as a subsection to D40GEN.		

17.0 ATTACHMENTS

Attachment 1. Adopted Editions of NFPA Fire Protection Codes, Standards, and Recommended Practices