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RECORD OF REVISIONS

Rev	Date	Description	POC	OIC
0	06/28/99	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 LANS transition. IMP and ISD number changes based on new Conduct of Engineering IMP 341. Master Spec 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 $1M. 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	04/05/18	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*

PLEASE CONTACT THE ESM FIRE POC
for upkeep, interpretation, and variance issues

Section D40	Fire POC/Committee

The LANL Eng Standards are available at http://engstandards.lanl.gov

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D40 GENERAL FIRE PROTECTION REQUIREMENTS

1.0 APPLICATION OF THIS CHAPTER

1.1 General

A. The purpose of this chapter of the Engineering Standards Manual (ESM) is to provide design requirements for fire protection systems so that these systems prevent accidents and mitigate consequences; are free from hazard; are efficient, convenient, and adequate for good service; and are maintainable, standardized, and adequate for future expansion. Code requirements are minimum requirements that are augmented by the site-specific requirements in this chapter.

B. All fire protection design, material, equipment, and installations shall comply with site-specific requirements in this Chapter of the ESM and others as applicable, most notably Chapter 1 General (especially Section Z10) and Chapter 16 IBC Program.

C. This chapter provides fire protection requirements and guidance for sprinkler piping systems and specialties downstream of the base of the riser, including the riser backflow preventer.

D. Follow ESM Civil Chapter 3 for requirements upstream of the base of the riser, e.g., fire hydrants, post indicator valves, piping, etc.

E. Refer to Subsection D4050 herein and ESM Chapter 15 Commissioning for expectations for testing and integrated commissioning of fire protection and life safety features.

2.0 ACRONYMS AND DEFINITIONS

Refer to ESM Ch. 1 Section Z10 for any not listed below.

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 Ch 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 (typically the manager of engineering). (see PD340)
ESM	LANL Engineering Standards Manual
FP-DO	LANL Fire Protection Division Office
FM	Factory Mutual, a nationally recognized testing laboratory
HPR	Highly protected risk or “improved risk.” 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 aspects of this [excerpted from PD 1220.0 definition] are: • substantial facility construction (i.e., fire-resistive and noncombustible), including interior fire-rated barriers and protection of openings, segregation of hazards and fire protection systems, • adequate (of sufficient capacity and duration) and reliable fire protection water

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Title	Description
	supplies, • automatic sprinkler protection where needed, • proper protection of special hazards, including special extinguishing systems where appropriate, protection of process hazards, and protection of special occupancy hazards, • supervision of facilities, including remote monitoring of fire protection systems, • control of and protection from severe fire exposures, including the aggregation of hazards posed by multiple tenants within a single facility, relocatable/temporary structures and wildland fire
IBC	International Building Code
IFC	International Fire Code
LAFD	Los Alamos County Fire Department
LBC	LANL Building Code
NFPA	National Fire Protection Association
NRTL	Nationally Recognized Testing Laboratory
UL	Underwriters Laboratories

3.0 CODES AND STANDARDS (REQUIRED UNLESS OTHERWISE INDICATED)

3.1 General

A. ESM Chapter 1 Section Z10 addresses some of the required codes, standards, CFRs, and LANL Engineering Standards. It also addresses how they and the ESM are to be applied, including topics such as precedence of documents, required edition, 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, not the POC, must approve any amendments (clarifications, variations, etc.) to this chapter.

3.2 DOE (Department of Energy) (selected, required Orders, Guides, and Standards)

Comply with the following (version per NNSA/LANL Contract):

A. DOE O 420.1, Facility Safety (in 420.1C: Att. 2, Chapter II)

B. DOE-STD-1212, Explosives Safety

C. DOE-STD-1066, Fire Protection

3.3 Building Code

A. International Building Code (IBC), International Existing Building Code (IEBC), and the International Fire Code (IFC),

1. Refer to ESM Chapter 16, IBC Program Section IBC-GEN (App A, LBC) for LANL-required editions and amendments

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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 among fire and life-safety requirements of the IBC, IFC, NFPA 101-Life Safety Code[1], and New Mexico and LANL amendments to these mandates in accordance with ESM Ch. 1 Section Z10 precedence requirements.

1. Doing so shall be considered to have met the "life safety" requirements of OSHA (29 CFR 1910).[2]

2. The LANL Fire Marshal is the Authority Having Jurisdiction (AHJ) for resolving what is most stringent and any mutually-exclusive conflicts among these documents.

3. Where the above codes refer to AHJ or the Administration Authority for Fire Protection matters, refer to the LANL Fire Marshal.

3.4 FM Global (FM) Insurance Co.

A. *Guidance: FM Property Loss Prevention Data Sheets*.

B. Current data sheets are available at: http://www.fmglobal.com/ (registration required)

3.5 NFPA (National Fire Protection Association)

A. National Fire Codes and Standards

B. Listing of current NFPA codes and standards is available at: http://www.nfpa.org/ ; LANL users have access here.

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

3.6 Society of Fire Protection Engineers

A. *Guidance: Fire Protection Engineering Handbook*.

3.7 XL CATLIN Global Asset Protection Services (XL GAPS) (formerly IRI)

A. Review *XL GAPS Guidelines* (formerly Industrial Risk Insurers) for additional guidance.

[1] Per ESM Ch 1 Section Z10 subsection on Codes and Standards (driven by NSEP-TP-1).
[2] Basis: PD 1220.0 *Fire Protection Program*, Section 3.1.2, also J. Streit memo (EMref 24). EMref refers to a Standards Program internal filing system for hard-to-find references.

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4.0 CONSTRUCTION

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 continuously revisited throughout the project with increasing attention to detail until the project is completed. These project considerations typically remain vital fire protection program elements through the useful life of the affected facility, and so will remain important beyond completion of a project after a facility construction project has been turned over to Operations.

B. Following 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 and access to the site and the facility, proximity/availability and condition of fire-fighting water including fire hydrants, nearby hazards to emergency responders, emergency responder pre-incident planning, emergency responder facility familiarity training, contaminated water run-off 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: materials of construction, fireproofing of structural elements, deflagration venting, flood/seismic/snow/wind design.
5. Mechanical/I&C 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, need for electrical equipment rated for hazardous locations.
7. Maintenance Considerations: equipment accessibility, frequency and methodology of required inspection/testing/maintenance (ITM), special equipment required to perform ITM.

4.2 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, etc., whichever is more restrictive (must evaluate both). Minimum construction for LANL facilities shall be IBC Type II-B or NFPA 220 Type II (000).[3]

[3] DOE O 420.1C, "Facility Safety," Ch II 3.c (2)(a), requires noncombustible construction for facility size > 5000 ft^2. Either Type II requirement is considered a reasonable implementation, since neither has a fire resistive rating requirement for the (1) exterior

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4.3 Construction Materials

A. NFPA 101 and the IBC define restrictions on materials that are used for construction. Specific restrictions that are important to the discipline of fire protection engineering include the following:

1. All materials that are to be used as part of a fire protection system, structure or component (SSC) shall be nationally-recognized testing laboratory (NRTL) Listed for the specified use.

Guidance: Interior finish materials restrictions (smoke developed and flame spread ratings) provide assurance that occupants of the structure will have a good chance to exit a building during a fire emergency. Flame spread rating restrictions help ensure that a fire will not spread with excessive speed. Smoke developed ratings help to ensure that occupants will be able to locate and reach exits.

2. *Guidance: Fire rating requirements for interior and exterior walls define the robustness of the structure when exposed to an interior or exterior fire.*

B. Design approaches that differ from—and modifications of—a Listed/Approved assembly require recertification by the Listing/Approving agency or approval of a DOE O 420.1C and/or NFPA equivalency request prior to assembly or item being acceptable for use.[4]

4.4 Fire Areas *(Guidance)*

A. Large structures, structures with multiple areas with different types of hazards, or structures with multiple types of occupancies (see Section 11.0, Life Safety Considerations) are often segmented into separate Fire Areas. A Fire Area is defined by fire-rated barriers. The purpose behind designating a Fire Area is to define the limits of a postulated fire starting within the Fire Area.

4.5 Fire Barriers

A. Fire barriers and associated ratings shall be indicated on drawings to support on-going inspection and maintenance and to support future modification work.

B. Where a wall or floor/ceiling is required as a fire barrier, its design shall have been tested in accordance with ASTM E119 or as described in NFPA 220, *Standard on Types of Building Construction*.

C. Additional requirements for fire barriers:

1. If fire areas are utilized to minimize potential property loss or mission continuity loss in a structure, barriers shall have a fire rating of not less than two (2) hours unless justified by the Fire Hazard Analysis.[5]

2. If fire barriers are utilized to segregate or minimize large (i.e., greater than $350 million baselined at CY2012 values) property loss potentials within a structure, barriers shall have a fire rating of not less than three (3) hours.[6]

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bearing walls; (2) columns, beams, girders, trusses and arches, supporting bearing walls, columns, or loads from more than one floor; or (3) floor construction (i.e., 0 hours allowed).

[4] Exceptions are where allowed by code/std. For example, NFPA 80 allows small changes to Listed assemblies. The code in these cases has clearly designated a set of small changes as not meeting the "field modification" threshold. [NFPA 80-2016 Par. 4.1.3, 5.5.7]. NFPA 80 (Par 5.1.5) also allows field modifications (other than those specifically code-allowed) with authorization from the manufacturer. Wording addresses NA-LASO-LANL-TA55-2013-0021, "Positive USQ: Oversize Fire Door Installed Without a UL Equivalency Granted by the AHJ," PFITS 2013-2393-CA3.

[5] DOE-STD-1066-12, Fire Protection, and DOE O 420.1C II ¶ 3.c(3)(b).

[6] DOE O 420.1C II ¶'s 3.c(2)(e) and 3.c(3)(b).

3. Occupancies within a structure shall be separated from other occupancies within the same structure as necessary to provide an increased level of life safety for the occupants in the structure per the IBC and NFPA 101.

4. Employ fire separation where necessary to separate the bulk of the structure from the passageways/stairways used to exit from the structure during an emergency to provide assurance that occupants will be able to safely exit a building during a fire emergency per IBC and NFPA 101.

5. 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.

4.6 Fire Barrier Penetrations

A. When a fire barrier is required for any reason, it shall be maintained in good condition as long as the structure is in operation. Openings/penetrations through a fire barrier shall be fire-rated to match the fire barrier rating. Designs for building modifications involving new penetrations shall indicate ratings of fire barriers being penetrated.

*Guidance: Because the integrity of fire barriers must be maintained for the life-cycle of the facility, an inventory of facility fire barriers, penetrations, and opening protective assemblies/devices/systems should be developed and subject to change control. This might take the form of barrier plans, penetration maps, or a database – commensurate with the quantity, complexity and expected rigor applicable to the barriers. 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 items penetrating the barrier (location, size, penetrating item). Note that the Firestopping Specification Section 07 8400 (*Article 1.4*) requires that the firestopping Subcontractor provide a complete schedule of fire and smoke barrier opening locations, sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of the fire barrier assembly.*

B. Seals, or “through-penetration firestop assemblies,” shall be Listed by UL, Approved by FM, or Listed by another nationally recognized testing laboratory (reference ANSI/UL 1479, *Fire Tests of Through-Penetration Firestops* and ASTM E814, *Standard Test Method for Fire Tests of Through-Penetration Fire Stops*). 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 support that it provides adequate fire protection, or it shall be reviewed and accepted by a fire protection engineer (LANL Fire Protection Division).

C. Ventilation Penetrations:

1. Ductwork penetrating a fire barrier (of greater than 1-hour fire-resistance) shall be equipped with a fire damper.[7] The design shall provide fire damper installation per manufacturer’s instructions, including provision of sufficient clearance around the fire damper for the fire damper to function correctly (the thermal expansion gap around an installed damper must still be protected appropriately); Adequate access shall be provided to permit inspection, testing and maintenance activities. Also refer to SMACNA Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.[8]

2. Where ductwork penetrates a fire barrier but no fire damper is required, the penetration shall be provided with a through-penetration firestop system around the penetration.

3. To prevent travel of smoke, a listed smoke damper, or a combined fire and smoke damper, shall be used.

[7] Foregoing this requires NFPA code/std or ESM Ch 2 SMPO permission.
[8] NFPA 90A, *Installation of Air Conditioning and Ventilating Systems.*

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4. Refer to ESM Chapter 6, Section D3040 HVAC Distribution, for additional fire/smoke damper requirements.

D. Doors:

1. Fire doors shall have the appropriate fire rating (reference NFPA 80, *Standard for Fire Doors and Other Opening Protectives*) to maintain the integrity of the barrier in which they are installed.

2. If a door must remain normally open, it shall be equipped with an appropriate mechanism to automatically close the door when there are fire conditions on either side of the barrier. This mechanism shall either be a fusible link allowing the door to close upon high temperatures, or an electromagnetic switch releasing the door upon smoke detection (in the vicinity of the door or area protection) or other initiating device actuation (e.g., manual pull stations, sprinkler system water flow indication, area heat detection). The release mechanism shall meet the requirements of the IBC and applicable NFPA code or standard for the specific application. Such mechanisms shall be UL Listed, FM Approved, or listed by another NRTL for the intended purpose *(e.g., fusible link release/closure of fire doors is not appropriate if the fire door is required for life safety compliance)*

E. Other Types of Penetrations:

1. Piping, cable trays, electrical conduits, and wires penetrating fire barriers shall be sealed. Refer to UL Fire Resistance Directory, Volume II, or the FM Global Approval Guide, or the listing guide of another NRTL, for listings of fire rated penetration seal assemblies.

Guidance: A simple and acceptable fire barrier penetration seal that should be considered for sealing of grouted or sleeved concrete masonry units or concrete barriers is grout, sealed to the full thickness of the penetrated wall or floor.

2. Where structural steel penetrates a fire rated barrier, that configuration shall be reviewed by a fire protection engineer (LANL Fire Protection Division) to determine if additional fire protection measures are required[9].

3. Windows through a fire barrier shall be in accordance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives*.
Guidance: Fire-resistant glazing in accordance with NFPA 80 can be used in an Approved/Listed assembly. Shutters or spray systems can be used to protect window openings in the event of a fire. Guidance is available from the LANL Fire Protection Division.

4. Where a conveyor penetrates a fire barrier, it shall be designed to maintain the fire rating of the barrier. *Guidance on how to accomplish this is available from the LANL Fire Protection Division.*

5.0 DESIGN DOCUMENTATION

5.1 Calculations

A. Calculation methods are presented in relevant NFPA codes, and software to conduct the calculations in accordance with these methods is available. Document and submit calculations for fire protection systems in accordance with LANL Engineering Procedure AP-341-605, *Engineering Calculations*, or equivalent.

[9] The steel can transmit significant heat from one side of the barrier to the other, potentially spreading fire.

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1. Refer to Subsection D4010 for hydraulic calculation requirements. *Guidance: For hydraulic calculations associated with nuclear facility sprinkler systems, consult with the Design Authority to identify additional requirements, if any*

B. Determine and document on drawings the occupancy classification by both the IBC and NFPA 101

C. Fire alarm system calculations (voltage drop, battery load calculations) are required when a new fire alarm system is designed or an existing system is modified. Refer to Section 8.3 for associated requirements.

5.2 Construction Documents

A. **Preparing Structure, System, or Component** (**SSC) Drawings**. Comply with the LANL CAD Standards Manual and the applicable NFPA code or standard.

B. **Seal design per** ESM Chapter 1 Section Z10 (*Design Output Submittals subsection).*

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.

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.

1. *Guidance: 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 run-off issues are also addressed as fire protection concerns in the same data sheet – e.g., oil run-off that exposes a different, unaffiliated structure downhill from a transformer, or lack of oil collection resulting in environmental contamination concerns (e.g., into the soil, into a canyon with wildland fire issues, etc. LANL Fire Protection Division is available to provide additional guidance*.

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C. Wild land Fire: NFPA 1144, *Standard for Protection of Life and Property from Wildfire*, and the International Wildland-Urban Interface Code (ICC), shall be used to determine how to evaluate the degree of wild land fire hazard for a particular facility. For explosives facilities, DOE-STD-1212 shall be used to determine special requirements for their protection.

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 LANL Fire Protection Division for guidance.

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

D. Lightning: All explosives facilities, all facilities with a replacement value of $5 million (baselined to CY2012 value) or more (structure and equipment/contents), and facilities of significant programmatic importance shall be equipped with lightning protection in accordance with the most stringent of the following[10]:

- NFPA 780, Standard for the Installation of Lightning Protection Systems,
- UL 96A, Installation Requirements for Lightning Protection Systems, and
- Lightning Protection Institute (LPI) Standard No. LPI-175 Standard of Practice.

When building project is below $5 million threshold, the determination of significant programmatic importance shall be made by the LANL Fire Marshal and facility and programmatic management prior to subcontracting for design services. [11]

Also reference LANL Master Specification Section 26 4100 series on lightning protection and DOE-STD-1212. For additional requirements refer to the ESM Electrical Chapter.

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."

1. As such, these items, as applicable to a given project, are Designated Seismic Systems (DSS). Refer to ESM Chapter 5 Section I (*paragraph 1.7*) for details pertaining to design and documentation requirements for DSS. Also, DSS that are/have active components are subject to Special Inspection and Testing as described in Chapter 16–IBC Program (see Section IBC-IP and its Attachment B Tables 1705.12 and 1705.13).

[10] Los Alamos County experiences intense and frequent lightning storm activity during the summer months, making lightning protection critical for all high-value or otherwise significant LANL facilities. $5M threshold from PD 1220 Section 3.1.3 as specified by DOE O 420.1C II ¶ 3.c(2)(c).

[11] PD 1220.0 purpose includes concept of 'unacceptable interruption of a Department of Energy (DOE) and/or National Nuclear Safety Administration (NNSA) designated "vital" program or loss of a LANL-designated "mission critical" program or activity as a result of a fire or related event.'

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8.0 FIRE DETECTION AND ALARM (D7050.10)

8.1 General

A. Provide a fire alarm system in every building or structure of such size, arrangement, or occupancy that a fire itself might not provide adequate occupant warning.[12] Also provide a fire alarm system if required by the *International Building Code*, NFPA 101, *Life Safety Code*, or LANL PD 1220, *LANL Fire Protection Program,* based on the occupancy classification. Coordinate fire alarm system selection with the LANL Fire Protection Division.

B. Design fire alarm system to meet the applicable requirements of the following codes and standards and this Chapter of the LANL Engineering Standards Manual:

1. NFPA 72, *National Fire Alarm and Signaling Code.*
2. NFPA 70, *National Electrical Code.*
3. NFPA 101, *Life Safety Code.*
4. NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems.*
5. ASME A17.1, *Safety Code for Elevators and Escalators*
6. ASME A17.3, *Safety Code for Existing Elevators and Escalators*
7. NECA 305, *Standard for Fire Alarm System Job Practices* (ANSI).

C. Use the materials and installation methods described in the following LANL Master Specification Sections:

1. Section 28 4600, *Fire Detection and Alarm* [use for all new systems]
2. Section 28 3110, *Fire Detection and Alarm -- Addition to Existing* [becoming 28 4601]

D. For new or extensively renovated facilities, provide addressable fire alarm systems.[13]

E. For additions or modifications to existing systems consult with the LANL Fire Protection Division to ascertain the appropriate alarm system technology to use. This will determine the arrangement of the system and the features that must be specified for the control panel alarm initiating devices, notification appliances, and accessory equipment. Record of this consultation shall be retained by the project.

F. Provide fire alarm systems with the following NRTL-listed fire alarm components as required by NFPA 72 and as necessary for a complete system:

1. Fire alarm control panel (FACP) to initiate sequences of operation for fire detection, notification, building system control, and fire suppression functions.
2. Conduit and wiring to connect the FACP to alarm initiating devices, notification appliances and auxiliary equipment.
3. Manual fire alarm station at each exit from each floor.[14]
4. Area smoke or thermal detectors where required by any NFPA code or standard, the IBC, ASME A17.1 (elevators), or DOE O 420.1C. Note that, with the

[12] NFPA 101 (§4.5.4 in 2015). A fire alarm system provides a reasonable level of safety by reducing the probability of injury and loss of life from fire, smoke, and heat in buildings by providing detection, suppression, and notification functions.

[13] The LANL Fire Protection Division has standardized on addressable systems for all new installations due to the low-initial cost, high capability, inherent communications, and ease of future component addition provided by such systems.

[14] Requirement for manually actuated initiating devices in NFPA 72 (§17.14.8.4 in 2013) overrides any exceptions that may be provided in NFPA 101.

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exception of special facilities such as computer rooms, area smoke or thermal detectors are not usually required in areas that are protected with automatic sprinkler systems.

Property protection guidance: Area smoke or thermal detection may be provided throughout a fire area as part of a 'redundant fire protection system' required for the protection of a large property loss potential (i.e., greater than $150 million baselined to CY2012 values) per DOE O 420.1C II 3.c(2)(d), and PD 1220. A fire hazards analysis (FHA) will document the requirements for and the type of fire protection SSCs needed to provide a 'redundant fire protection system.'

5. Duct smoke detectors and air handling systems shutdown relays where required by NFPA 90A and NFPA 72. Where duct smoke detectors are installed in difficult to access locations, a remote test device and indicator light shall be provided in an accessible location.
6. Connections to sprinkler waterflow/pressure alarm switches.
7. Connections to sprinkler system control valve and pressure supervisory devices.
8. Sounder and synchronized signal strobe combination notification appliances.
9. Supervision for Knox key box (GFE, as specified by the LANL Fire Marshal)
10. Elevator recall/shunt relays (if the building has an elevator) as required by ASME A17.1.
11. Fire/smoke door releasing functions.
12. Battery standby capable of operating the fire alarm system under maximum quiescent load (system functioning in a non-alarm condition with supervisory and trouble signals operating) for 24 hours, and at the end of that period operating all alarm notification appliances for not less than 10 minutes.[15]
13. Digital alarm communicator transmitter (DACT) to send point-identified alarm, supervisory, and trouble signals to the LANL Proprietary Fire Alarm System.
14. Conduit and GFE cable from the FACP to building's main telecommunications room.
15. Surge protection for line power circuits serving the fire alarm system.
16. Surge protection and/or isolation modules for initiation, notification, and signaling circuits that extend beyond the building or are otherwise exposed to lightning.
17. Surge suppression devices and isolation modules shall be installed in locations that are readily accessible from grade level to allow routine investigation, maintenance and replacement.

G. In general, each building that warrants a fire alarm system shall have its own fire alarm control panel.[16]

H. Digital alarm communicator transmitter (DACT) reporting format to the LANL Proprietary Fire Alarm System shall be "Contact ID" capable of encoding specific point identification.[17]

[15] Ten minutes is doubling of 5-min stated in NFPA 72 Secondary Power Supply article (§10.6.7.2.1 in 2013).
[16] The connection of several satellite buildings to a single FACP increases system complexity, exposes initiating and alarm circuits to lightning, and potentially leaves the satellite buildings without fire alarm due to events in the main building.
[17] The LANL Fire Protection Division has standardized on the "Contact ID" reporting format because it is capable of transmitting initiating device level alarm information to the Proprietary Fire Alarm System.

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8.2 Functional Requirements for Addressable Systems

A. The system shall identify any off normal condition and log each condition into the system database as an event.

1. The system shall automatically display on the control panel the first event of the highest priority by type. The priorities and types shall include alarm, supervisory, and trouble.
2. The system shall have a queue operation, and shall not require event acknowledgment by the system operator. The system shall have a labeled color coded indicator for each type of event.
3. The user shall be able to review each event by selecting scrolling keys.
4. New alarm, supervisory, or trouble events shall sound a silenceable audible signal at the control panel.

B. Operation of any alarm-initiating device shall automatically:

1. Update the control/display as described above.
2. Sound all alarm signals throughout the building. The fire alarm evacuation tone shall be the ANSI S3.41, *Audible Emergency Evacuation Signal* three-pulse temporal pattern.[18]
3. Turn on all strobe lights throughout the building.
4. Visually and audibly annunciate the alarm condition at the fire alarm control panel.
5. Operate the alarm relay and initiate the transmission of a point-identified alarm signal to the LANL Proprietary Fire Alarm System over a digital alarm communicator system.
6. Operate control relay(s) to shut down HVAC units serving the floor of alarm initiation.
7. If there is an elevator, operate control relay(s) to return all elevators that serve the floor of alarm initiation to the ground floor. If the alarm originates from the ground floor, operate control circuits contacts to return all elevators to the floor above or to a level as directed by the LANL Fire Protection Division.
8. Shut down power to elevator equipment before sprinkler operation in the elevator equipment room.
9. Operate other auxiliary devices as required.

C. Activation of a supervisory signal-initiating device shall:

1. Update the control/display as described above.
2. Visually and audibly annunciate the supervisory condition at the fire alarm control panel.
3. Operate the supervisory relay and initiate the transmission of a supervisory signal to the LANL Proprietary Fire Alarm System over a digital alarm communicator system.

D. The fire alarm system wiring shall be electrically supervised to automatically detect and report trouble conditions to the fire alarm control panel. Any opens, grounds or derangement of system wiring and shorts across alarm horn/strobe wiring shall automatically:

[18] Refer to Distinctive Evacuation Signal section in NFPA 72 (§18.4.2 in 2013).

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1. Update the control/display as described above.
2. Operate the trouble relay contacts to initiate the transmission of a trouble signal to the LANL central station over a digital alarm communicator system.
3. Visually and audibly annunciate a general trouble condition, on the FACP. The visual indication shall remain on until the trouble condition is repaired.

8.3 System Design and Documentation

A. Fire alarm systems shall be both designed and installed by fire alarm contractors that are experienced in their proper design, application, installation, and testing.[19]

B. Design Agency shall provide performance specifications based on LANL Master Specification Section 28 4600 or 28 3110 (becoming 28 4601).

C. The fire alarm Subcontractor will provide the services of a qualified fire alarm designer factory trained for the FACP to be installed on the project. The fire alarm designer shall assure the completeness and correctness of the fire alarm system design by preparing and submitting the following for review by the LANL Fire Protection Division:

1. Shop drawings of the FACP indicating location of components, interconnection of components and connections to alarm initiating, indicating, and auxiliary circuits.
2. Fire alarm riser diagram showing new and existing alarm initiation circuits, alarm appliance circuits, input/output functions, and communications connections.[20] Show all new and existing fire alarm devices and the corresponding room numbers. Refer to Example Drawing ST-D5030-2.
3. System input/output matrix showing the system actions in response to alarm, supervisory, and trouble conditions. Refer to Example Drawing ST-D5030-2.
4. Floor plan drawings of fire alarm layout, conduit, and wiring. Show location of all fire alarm appliances, conduit layout, quantity, and type of wires in each conduit, and interface with other systems for functions such as central station signaling, fan shutdown, damper operation, and elevator recall.
5. Terminal-to-terminal field wiring diagrams for alarm initiating, indicating and auxiliary circuits; detail the interfaces with other systems; indicate labeling of each fire alarm system conductor.
6. Conductor size calculations for each alarm initiating, indicating, and auxiliary circuit; limit voltage drops so that they do not exceed the FACP manufacturer's limitations for the most remote device on each circuit.[21]
7. Battery load calculations for the FACP and any remote power supply panels and selection of proper battery size, including specified design margin.
8. Audible alarm signal calculations, or confirmation via testing at the commissioning phase, for all spaces demonstrating that the design complies with NFPA 72 requirements of alarm signal a minimum of 15 dB above ambient at all locations, but not over 110 dBA at any location.[22]
9. Selection of initiating, indicating, and auxiliary devices compatible with the FACP.

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[19] Refer to NFPA 72 (§10.5.1, 5.2, A.24.7.2, Table A.26.1 in 2013).
[20] The fire alarm riser diagram and associated input-output matrix show the functional interconnections of initiating devices, notification appliances, and controlled systems.
[21] Lesson-learned from several previous fire alarm projects.
[22] NFPA 72's Audible Characteristics (§18.4.1.2 and 18.4.3.1 in 2013)

10. As-built drawings showing all changes to design documents.[23]

8.4 Installation

A. Install fire alarm systems in accordance with NECA 305, *Standard for Fire Alarm System Job Practices* (ANSI).

B. The FACP DACT will be connected by the LANL Telecommunications Group as follows:

1. *In new facilities and where possible in existing facilities, the DACT will be connected to two separate dedicated analog telephone lines (numbers) on the public switched network.*
2. *Where two dedicated lines are not available, the LANL Fire Protection AHJ **may** grant special permission to use existing voice grade DTMF analog telephone lines within the protected premises. Preference is low-use telephone lines such as lobby, conference room or break room numbers. Lines that carry data transmission such as fax machines or data modems cannot be used. Personal desktop telephone numbers will only be used if no other low use lines are available. Lines that may be required for emergency use will not be used.*
3. *Each connection will be made to a loop start telephone circuit that provides a timed release disconnect.*
4. *For non-dedicated lines, two RJ31X jacks will be installed in the FACP. One will be labeled "PRIMARY" and the other "SECONDARY". For the "PRIMARY" jack cable pair 1 (blue) will be connected to the primary line and pair 2 (orange) to the premise telephone (if any). For the "SECONDARY" jack cable pair 3 (green) will be connected to the secondary line and pair 4 (brown) to the premise telephone (if any).*

8.5 Acceptance Testing and Inspection

A. Test installed fire alarm system in accordance with Project's version of LANL Master Specification 28 4600 *Fire Detection and Alarm* and NFPA 72.[24] Use an inspection and testing form acceptable to the AHJ.[25]

B. Notify the LANL AHJ before conducting acceptance testing and inspection. Furnish a written statement to the AHJ stating that the system has been installed in accordance with approved plans and tested in accordance with the manufacturer's specifications and the appropriate NFPA requirements.[26]

C. Provide "Record of Completion" upon successful acceptance test and inspection.[27]

9.0 FIRE PREVENTION FEATURES

A. Fire prevention features shall be part of the project plans and specifications just as fire protection systems would be.

1. **Combustion Safeguards on Fuel-Fired Equipment**. Follow NFPA 85, *Boiler and Combustion Hazards Code,* and NFPA 86, *Standard for Ovens and Furnaces*.

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[23] Accurate design and as-built documentation facilitates maintenance and future system modifications.
[24] NFPA 72 Inspection, Testing, and Maintenance chapter (Ch 14 in 2013)
[25] NFPA 72 Record of Completion (§7.5.6 in 2013).
[26] Approvals and documentation per NFPA 72 (§7.5.8 in 2013).
[27] Concept and form per NFPA 72 Record of Completion (§7.5.6 in 2013)

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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. Follow NFPA 115 for laser laboratories and operations.

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 NFPA 30; NFPA 801, *Standard for Fire Protection for Facilities Handling Radiological Materials*; and NFPA 15 annex.

6. **Prevention of Potentially Contaminated Firefighting Water Run-off**. 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.

7. **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.

8. **Process Monitoring and Interlocks**. Monitor all parameters of a process that could contribute to fire or explosion. Parameters to be considered include but not be limited to pressure, temperature, flow, concentration, agitation, liquid levels and positions of doors and dampers.

9. **Programmatic Combustible Loading**. Design buildings and processes to enable keeping combustible loading at the minimum necessary for normal operations.

10.0 INSTALLATION AND TESTING

A. **System Impairment Process**. Follow Criterion 733, Fire Protection System Impairment Control Program, in the LANL Operations and Maintenance (O&M) Manual.

B. **Inspection, Testing, and Maintenance (ITM) Criteria**. Follow the inspection, testing, and maintenance criteria outlined in Section 700 of the LANL O&M Manual.

11.0 LIFE SAFETY CONSIDERATIONS

A. For explosives facilities, comply with additional life safety requirements in DOE-STD-1212.

B. Emergency lighting and marking of the means of egress shall be provided as required by IBC and NFPA 101. Refer to the ESM Electrical Chapter for additional requirements.

C. *Life safety feature guidance:*

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1. *Once the occupancy has been identified, IBC and NFPA 101 specify the life safety features required for the occupancy. These features ensure that occupants of the building will have sufficient early warning and sufficient exits to facilitate safe egress from the building.*
2. *Pay special concern to:*
   a. *Travel distance from any part of the building to the nearest exit;*
   b. *Maximum allowed dead end corridor allowed in the building; and*
   c. *The portion of exit access that is traversed before two separate and distinct paths of travel to two exits are available (common path of travel).*

   The limits associated with these features vary by occupancy, and vary for any occupancy type depending on whether or not the building is sprinkler-protected. Where sprinklers are provided, the allowed distances related to exit access, generally increase. The presence of sprinklers provides twofold assurance: first, that a fire will be promptly controlled, limiting fire and smoke spread; and second, that the exit pathway will remain protected long enough to get occupants safely out of the building.

12.0 PRE-EMERGENCY PLANNING PROGRAMS

A. Coordinate with LANL FP Division to provide documentation to LAFD describing a new facility or changes to an existing facility so that the Pre-Incident Plans can be kept up to date. *Guidance: The Los Alamos County Fire Department (LAFD) develops and maintains Pre-Incident Plans for important LANL facilities, to aid fire fighters in responding to a facility fire*.

B. *Guidance: Generic guidance on fire water run-off 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 entitled, "Guidance for Estimating Fire Suppression System Run-off Volume in DOE Nuclear and Hazardous Substance Locations." Additionally, the Pre-Incident Plans for each facility address some aspects of firewater run-off. Where there is no specific requirement for fire protection water run-off control at a facility (i.e., required by a Documented Safety Analysis), the facility must monitor firefighting water run-off 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 run-off*.

C. Coordinate with LANL FP Division and/or Security & Emergency Operations (SEO) to provide up-to-date information on any changes to an existing facility's physical hazards or hazard configuration, so that Pre-Incident Plans can be updated. *Guidance: Fire fighters may encounter a variety of different physical hazards at LANL facilities, including radiological, chemical, cryogen, laser, etc.*

D. For new or significantly modified facilities, especially those with an Emergency Planning Hazards Assessment (EPHA), coordinate with the LAFD through SEO and FP-DO to ensure that LAFD personnel are provided with appropriate tours.

E. Evacuation plans and Building Run Sheets are required in each facility at LANL. When facility configurations are changed the evacuation plans and Building Run Sheets shall also be changed. Coordinate with Facility Management for evacuation plans. Coordinate with SEO for Run Sheets and Response Guides.[28]

F. Provide fire department access roads (e.g., 'fire lanes') to buildings, fire hydrants, sprinkler system fire department connections and related equipment in accordance with NFPA 1,

[28] PD 1200, Emergency Management.

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Fire Code, and the International Fire Code (IFC). This includes the marking of and signage for fire lanes in accordance with LANL Fire Protection Program Manual, FPPM-1220-100, Fire Department Access.

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. 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.

14.0 SPECIAL FIRE/EXPLOSION HAZARDS

A. Special fire and explosion hazards include but are not limited to the following:

1. Warehousing. Follow NFPA 13.
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, but not limited to, NFPA 30, NFPA 45, and NFPA 318, *Standard for the Protection of Semiconductor Fabrication Facilities*.
3. Flammable and Combustible Materials. Follow relevant NFPA codes, including, but not limited to NFPA 30 and the NFPA codes on flammable gases, oxidizers, peroxides, and combustible metals.
4. Explosive materials. Follow DOE-STD-1212, Explosives Safety, and NFPA 495, *Explosive Materials Code*.
5. Paint Spraying/Coating. Follow 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*.
6. Tank Storage of Liquids. Follow NFPA 30 and the appropriate NFPA codes for tank protective systems, including NFPA 15 and NFPA 16.
7. Information Technology Occupancies. Follow NFPA 70, NFPA 75, *Standard for the Fire Protection of Information Technology Equipment*, and FM Global 5-32 for computing and data processing occupancies; follow NFPA 76, *Standard for the Fire Protection of Telecommunications Facilities,* for telecommunications occupancies.

D4010 FIRE SUPPRESSION

1.0 GENERAL

A. This section provides requirements/guides for sprinkler system piping downstream of the base of the system riser. This section addresses wet pipe, dry pipe, and pre-action sprinkler systems. For deluge and other special-hazard systems, refer to Subsection D4010.50 *Special Fire Extinguishing Systems*, below.

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2.0 DESIGN REQUIREMENTS

A. Provide a complete automatic fire suppression system for a new or modified structure where: [29]

1. The maximum possible fire loss (MPFL) exceeds $5 million (baselined to CY2012 values) (structure and equipment replacement, post-fire clean-up, and post-fire recovery costs);
2. The size of the protected structure exceeds 5,000 sq. ft. of floor area;
3. Determined necessary by the LANL Fire Protection Division due to the mission importance of the structure;
4. Required by a safety basis document (for example, to prevent loss of safety functions or provide defense-in-depth); or
5. Required in response to significant life safety hazards;

Guidance: LANL Fire Protection Division decision on the need for automatic fire suppression system protection should be made prior to subcontracting design services. Such a suppression system need not be an automatic fire sprinkler system if approved by the LANL Fire Marshal.

B. For asset/property protection, multiple fire protection approaches, such as an automatic fire suppression system and a fire detection and alarm system, must be provided in areas where the MPFL exceeds $150 million (baselined to CY2012 values; refer to DOE-STD-1066).

C. For asset/property protection, fire areas must be established such that the MPFL for each fire area does not exceed $350 million (baselined to CY2012 values). Fire area walls or other separation approaches may be used to meet this requirement; refer to DOE-STD-1066.

D. The minimum design area for an automatic sprinkler system shall be 1,500 square feet unless bounded on all sides by either a 2-hour fire-rated interior barrier or exterior walls. Hydraulically designed systems shall be designed at least 10 psig or 10% (whichever is greater) below the water supply curve.

E. Provide a hydraulically designed automatic sprinkler system for protection of an NFPA 13, *Standard for the Installation of Sprinkler Systems*, Ordinary Hazard Group 2 (OH2) occupancy as a minimum, except as approved otherwise by the LANL Fire Marshal.

F. Provide a separate fire protection service line into the building, except as approved otherwise by the LANL Fire Marshal.

G. Provide backflow preventers on all new fire protection system risers and upstream of fire protection systems containing foam or anti-freeze solutions where connected to a potable water source. Refer to the ESM Mechanical Chapter, Section D20 subsection on Cross Connection Control, for additional requirements.

H. Anti-freeze sprinkler subsystems shall be filled with a Listed/Approved manufacturer pre-mixed solution of 48% glycerin (GL48).

I. Where concealed spaces are formed by non-combustible construction but contain combustible materials (cable trays, combustible insulation, piping carrying flammable/combustible liquids, etc.), fire protection shall be provided in the space using

[29] $5M threshold from PD 1220 Section 3.1.3 as specified by DOE O 420.1C II 3.c(2)(b).

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the same requirements in NFPA 13 for combustible concealed spaces. Freeze protection shall also be addressed.

J. In consultation with the LANL Fire Protection Division, provide sprinkler system with a minimum number of control valves. Provide outside stem and yoke (OS&Y) valves with a tamper switch.

K. Sprinkler systems shall be monitored by a fire alarm panel in accordance with NFPA 72 and shall report locally and remotely to the LANL Proprietary Fire Alarm System.

L. The design of suppression systems for the protection of high efficiency particulate air (HEPA) filters shall include testing features that do not require wetting of the filter media.

M. The LANL Fire Protection Division will provide water flow test data upon request.

N. Prepare fire suppression system drawings in accordance with the LANL Drafting Standards Manual and applicable NFPA installation standards.

O. Provide a minimum of 500 gpm for hose stream allowance for water-based fire suppression systems, unless otherwise required by the Fire Hazard Analysis (FHA) and/or with concurrence by the LANL Fire Marshal.

P. Provide an initiating alarm device (sprinkler system flow or pressure switch) for each area and floor of the building protected by sprinklers, as determined in consultation with FP-DO, to assist the Fire Department in determining the location of a fire during an emergency.

Q. Nuclear: Sprinkler systems designated by documented safety analyses as safety significant (SS) or safety class (SC) are subject to additional design, material, construction, quality assurance (QA), and inspection, testing and maintenance (ITM) requirements of DOE-STD-1066 Appendix A. Quality shall also comply with ESM Chapter 1 General. Seismic design shall comply with ESM Chapter 5 Structural.
Guidance: Consider use of ASME B31E, Standard for the Seismic Design and Retrofit of Above-Ground Piping Systems*, for "low-hazard nuclear (i.e., SDC-1 and -2)*." For "high-hazard nuclear (i.e., SDC-3)," ESM Ch. 5 Section III must be met.

R. The anticipated operation, or inadvertent operation and failure, of the sprinkler system must not result in the loss of function of other designated SC or SS systems, structures or components (SSCs).

S. Standpipe requirements for standpipe system piping downstream of the base of the system riser:

1. Provide standpipe systems when required by the NFPA Codes or the IBC. Also provide in structures with extensive or complex interior layouts, or in structures where exterior doors cannot be held in the open position due to security or ventilation/radiation safety requirements.[30]
2. Comply with requirements of IBC and NFPA 14, *Standard for the Installation of Standpipe, Private Hydrant, and Hose Systems*. Consultation with the LANL Fire Protection Division and the Los Alamos Fire Department (LAFD) on the type and performance of a new standpipe system is required, with final approval by the LANL Fire Marshal.
3. Design standpipe systems in accordance with IBC and NFPA 14.

[30] DOE-STD-1066-12, ¶ 4.2.7.5, requires appropriate equipment to facilitate effective intervention.

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T. Refer to the following LANL Standards. Specs here.

1. Master Specification 21 1313, Wet-Pipe Sprinkler Systems.
2. Master Specification 21 1316, Dry-Pipe Sprinkler Systems.
3. Master Specification 21 1319, Preaction Sprinkler Systems.
4. Fire Protection Drawings ST-D4010-1, Sprinkler System Riser Details.

D4010.50 SPECIAL FIRE EXTINGUISHING SYSTEMS

1.0 SPECIAL FIRE EXTINGUISHING SYSTEMS

A. Provide special extinguishing systems to protect hazards that cannot be adequately protected by automatic sprinklers alone. Select the most appropriate combination of detection, extinguishing agent, and extinguishing system design for the hazard.

B. Follow as applicable NFPA 11, 11A, 12, 15, 16, 17, 17A, 69, 750, 2001, and other applicable NFPA codes, standards, and recommended practices. Do not install new Halon 1301 systems, but maintain any existing systems in accordance with NFPA 12A.

C. Follow as applicable the following LANL Standards available here:

1. Master Specification Section 21 1326, Deluge Fire Suppression Sprinkler Systems
2. Master Specification Section 21 1339, Foam-Water Systems
3. Master Specification Section 21 2200, Clean Agent Fire-Extinguishing Systems

D4030 FIRE PROTECTION SPECIALTIES

1.0 PORTABLE FIRE EXTINGUISHERS

A. Fire extinguisher types, locations, and signage shall be in accordance with NFPA 10, Standard for Portable Fire Extinguishers. Information on proposed fire extinguishers shall be reviewed by the project point of contact in the LANL Fire Protection Division prior to purchasing and installation.

B. *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. LANL Master Specification 10 4400, Fire Protection Specialties, addresses these.

D4050 COMMISSIONING FIRE PROTECTION AND LIFE SAFETY[31]

This section provides a general summary of commissioning requirements and expectations for new and modified fire protection and life safety systems, structures and components (SSCs) installed with LANL buildings and facilities. This section is intended to augment the basic expectations described in ESM Chapter 15 Commissioning, provide alignment with Chapter 16 IBC Program, and provide consistency as recommended within NFPA 3*, Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems*, and NFPA 4, *Standard for Integrated Fire Protection and Life Safety System Testing*. NFPA 3 and NFPA 4

[31] Added per PFITS #2011-504 CA #2

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describe a framework for the commissioning and integrated testing processes for the following active and passive fire protection and life safety SSCs to ensure conformity with the design intent:

(1) Infrastructure supporting building fire protection and life safety SSCs
(2) Fixed fire suppression and control systems
(3) Fire detection and alarm systems, including occupant notification
(4) Remote alarm transmission to the LANL proprietary fire alarm system
(5) Smoke control and management systems
(6) Normal, emergency and standby power systems
(7) Explosion prevention and control/relief systems
(8) Fire-resistant and smoke-resistant assemblies
(9) Opening protective and through-penetration firestop systems
(10) SSCs protecting commercial cooking operations
(11) Elevator systems
(12) Means of egress SSCs
(13) Spill collection/containment, water run-off control features
(14) Process control and safety SSCs
(15) Access control SSCs

Note: In the following, "Contractor" shall be taken to mean the Subcontractor or subtier Subcontractor performing the work for LANL.

1.0 FIRE PROTECTION INFRASTRUCTURE

A. Fire protection water supply storage tanks shall be inspected and commissioned in accordance with NFPA 22, *Standard for Water Tanks for Private Fire Protection*, and applicable AWWA standards for potable water storage tanks. Tank manufacturer/erector and/or representative shall document inspection and commissioning results within an inspection report.

B. Fire protection pumps and associated appurtenances (piping, valves, pressure maintenance pumps, controllers, fuel systems, battery systems, testing devices, enclosures, etc.) shall be inspected and commissioned in accordance with NFPA 20, *Standard for Installation of Stationary Pumps for Fire Protection*. Documentation of commissioning results shall include a Contractor's Material and Test Certificate for Private Fire Service Mains (suction and discharge piping to/from the fire pumps), a Contractor's Material and Test Certificate for Fire Pump Systems (one for each pump), and manufacturer's certified pump test characteristic curve for validating as-installed performance.

C. Fire protection water supply distribution systems and associated appurtenances (block valves, pressure reducing valves, control valves and fire hydrants) shall be inspected and commissioned in accordance with NFPA 24, *Standard for the Installation of Private Fire Service Mains and their Appurtenances*, and applicable AWWA standards for potable water systems where applicable. Testing shall include verification of available fire flow in comparison with original design calculations. Documentation of commissioning results shall include a Contractor's Material and Test Certificate for Private Fire Service Mains.

D. Fire lanes and associated marking and signage shall be inspected in accordance with NFPA 1, *Fire Code*, and the *International Fire Code* criteria for "Fire Department Access." Inspection shall include verification of intended fencing, gates, Knox key box, fire hydrant, fire department connection (FDC) and apparatus accessibility.

2.0 WATER-BASED FIRE SUPPRESSION SYSTEMS

A. Automatic sprinkler systems (wet-pipe, dry-pipe, preaction, deluge) shall be inspected and commissioned in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*. Documentation of commissioning results shall include a Contractor's Material

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and Test Certificate for Underground Piping (lead-in piping), a Contractor's Material and Test Certificate for Above Ground Piping, and a listing of the sprinklers installed within the facility (posted at the spare head cabinet). The type and quantity of factory-premixed anti-freeze solution shall also be posted at the control valve of any anti-freeze sub-system.

B. Water spray fixed systems shall be inspected and commissioned in accordance with NFPA 15, *Standard for the Installation of Water Spray Fixed Systems*. Documentation of commissioning results shall include a Contractor's Material and Test Certificate for Underground Piping (lead-in piping), a Contractor's Material and Test Certificate for Water Spray Systems, and a listing of the spray nozzles installed within the facility (posted at the spare head cabinet).

C. Automatic foam-water sprinkler systems shall be inspected and commissioned in accordance with NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*. Documentation of commissioning results shall include a Contractor's Material and Test Certificate for Underground Piping (lead-in piping), a Contractor's Material and Test Certificate for Above Ground Piping (NFPA 13), a listing of the sprinklers installed within the facility (posted at the spare head cabinet), and confirmation of the compatibility of the foam concentrate, foam concentrate storage tank, foam proportioning devices, and sprinkler heads/spray nozzles.

D. Standpipe systems shall be inspected and commissioned in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*. Documentation of commissioning results shall include a Contractor's Material and Test Certificate for Underground Piping (lead-in piping), and a Contractor's Material and Test Certificate for Above Ground Piping.

3.0 CLEAN AGENT EXTINGUISHING SYSTEMS

A. Carbon dioxide (CO_2) extinguishing systems shall be inspected and commissioned in accordance with NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*. Installing vendor and/or manufacturer's representative shall document inspection and commissioning results within an inspection report, including enclosure integrity testing results.

B. Clean agent (e.g., FM 200, Inergen, Argonite, Novec 1230, etc.) extinguishing systems shall be inspected and commissioned in accordance with NFPA 2001, *Standard on Clean Agent Extinguishing Systems*. Installing vendor and/or manufacturer's representative shall document inspection and commissioning results within an inspection report, including enclosure integrity testing results.

4.0 CHEMICAL EXTINGUISHING SYSTEMS

A. Dry chemical extinguishing systems shall be inspected and commissioned in accordance with NFPA 17, *Standard for Dry Chemical Extinguishing Systems*. Documentation of commissioning results shall include a Dry Chemical System Acceptance Test Report prepared by the installing vendor and/or manufacturer's representative, including confirmation of any auxiliary functions/controls and enclosure integrity test results.

B. Wet chemical extinguishing systems shall be inspected and commissioned in accordance with NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*. Documentation of commissioning results shall include a Wet Chemical System Acceptance Test Report prepared by the installing vendor and/or manufacturer's representative, including confirmation of any auxiliary functions/controls and enclosure integrity test results.

5.0 FIRE DETECTION AND ALARM SYSTEMS

A. Fire detection and alarm systems shall be inspected and commissioned in accordance with NFPA 72, *National Fire Alarm and Signaling Code*. Documentation of commissioning results shall include a Record of Completion. Commissioning shall include proper integration and functionality of the control unit and remote power supply panels, battery load demands, all initiating devices, notification appliances and features (e.g., emergency

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responder microphones), auxiliary functions (e.g., elevator controls, HVAC controls, fire door release, smoke dampers, process interlocks, smoke management systems, etc.), NFPA 72-compliant electrical supervision of fire suppression systems and equipment, remote annunciators, and alarm transmission to the LANL proprietary fire alarm system.

6.0 PASSIVE FIRE PROTECTION AND LIFE SAFETY FEATURES

A. Fire-resistant walls, floor/ceiling systems, barriers and partitions shall be inspected in accordance with the *IBC*, NFPA 101, *Life Safety Code*, and NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls*, to confirm conformity to the design drawings and specifications. Spray-applied, and mastic and intumescent fire-resistant materials and coatings, respectively, utilized as components of a fire-resistant barrier are subject to Special Inspection and Testing as described in Chapter 16 – IBC Program (ref. IBC-2015 Section 1705.14, 1705.15).

B. Fire-resistant penetrations and joints in high-rise buildings or in buildings assigned to Risk Category III or IV are subject to Special Inspection and Testing as described in Chapter 16 – IBC Program (ref. IBC-2015 Section 1705.17).

C. Smoke-resistant walls, floor/ceiling systems, barriers and partitions shall be inspected in accordance with the *IBC* and NFPA 101, *Life Safety Code,* to confirm conformity to the design drawings and specifications.

D. Fire doors, windows and glazing systems within fire- and smoke-resistant barriers shall be inspected in accordance with the *IBC*, NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, and NFPA 101, *Life Safety Code*, to confirm conformity to the design drawings and specifications. Door hardware, access control and other security features are verified to be consistent with fire door assemblies and life safety means of egress requirements.

E. Fire dampers, smoke dampers, and combination fire/smoke dampers within fire- and smoke-resistant barriers shall be inspected in accordance with the *IBC*, NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilation Systems*, and NFPA 101, *Life Safety Code*, to confirm conformity to the design drawings and specifications. Where dampers cannot be provided within ductwork for operational reasons (e.g., exhaust systems), external duct wrap systems shall be inspected in accordance with NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists and Noncombustible Particulate Solids*, to confirm conformity to the design drawings and specifications.

F. Electrical and Mechanical penetrations into and through fire- and smoke-resistant barriers shall be inspected to verify that specified listed/approved through-penetration firestop systems have been properly installed and labeled in accordance with the *IBC*, NFPA 101, *Life Safety Code*, and NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls*.

G. Spill collection (e.g., oil-filled transformer basins) and fire suppression water run-off containment/collection features shall be inspected to confirm conformity to the design drawings and specifications (e.g., NFPA 15, *Standard for the Installation of Water Spray Fixed Systems*, NFPA 30, *Flammable and Combustible Liquids Code*, NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*, etc.).

7.0 LIFE SAFETY FEATURES

A. Portable fire extinguishers shall be inspected (i.e., location/spacing, accessibility, rating, compatibility with hazards, and signage) in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*, to confirm conformity to the design drawings and specifications.

B. Means of egress features (i.e., exit access paths, exit enclosures, horizontal exits, stairs, and doors) shall be inspected in accordance with the *IBC* and NFPA 101, *Life Safety Code*, to confirm conformity to the design drawings and specifications. Access control and other security features shall be verified to be consistent with life safety means of egress requirements.

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C. Emergency lighting and exit signage shall be inspected in accordance with the *IBC* and NFPA 101, *Life Safety Code*, to confirm conformity to the design drawings and specifications. Battery-operated units shall be tested to confirm illumination levels and duration satisfy NFPA 101 Section 7.9 and 7.10 performance requirements.

D. Emergency power systems supporting life safety-related systems and features shall be inspected and commissioned in accordance with the *IBC*, NFPA 101, *Life Safety Code*, and NFPA 110, *Standard for Emergency and Standby Power Systems*, to confirm conformity to the design drawings and specifications. Installing vendor and/or manufacturer's representative shall document inspection and commissioning results within an inspection report.

E. Smoke control and management systems shall be inspected and commissioned in accordance with the *IBC*, NFPA 101, *Life Safety Code*, NFPA 92A, *Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences, and/or NFPA 204, Standard for Smoke and Heat Venting*, to confirm conformity to the design drawings and specifications. Commissioning shall be performed under the direction and supervision of the Engineer of Record and be documented within an inspection report. Smoke control and management systems are subject to Special Inspection and Testing as described in ESM Chapter 16, IBC Program, Section IBC-IP.

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