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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*

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

Section Z10	**Fire POC/Committee**

The LANL Eng Standards including this one are available to all at http://engstandards.lanl.gov

D40 GENERAL FIRE PROTECTION REQUIREMENTS

1.0 APPLICATION OF THIS CHAPTER

1.1 General

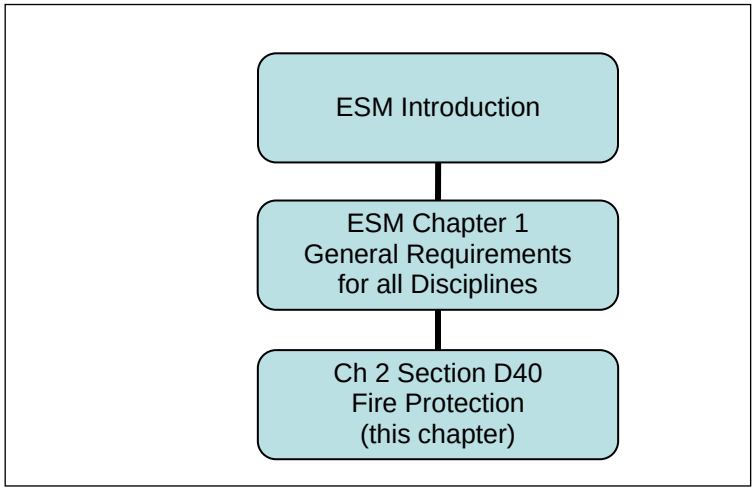
A. This chapter provides fire protection requirements and guidance for sprinkler piping systems and specialties downstream of the base of the riser, including the riser backflow preventer. The requirements and guidance apply to all existing and new LANL facilities, designs for new construction, and for modifications to existing buildings and structures.

B. Refer to the LANL Engineering Standards Manual (ESM) Civil Chapter for requirements upstream of the base of the riser, i.e., fire hydrants, post indicator valves, piping, etc.

C. The purpose of this chapter of the ESM is to provide fire protection systems that 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.

D. All fire protection design, material, equipment, and installations shall comply with site-specific requirements in this Chapter and the Introduction and Chapter 1 of the ESM.

This hierarchy and the organization of this chapter are depicted below:



2.0 ACRONYMS AND DEFINITIONS

Title	Description
AHJ	Authority having jurisdiction. The LANL Fire Marshal is the AHJ for this ESM Chapter; however, engineering standard-related inquiries should be initially directed to the ESM Fire POC.
Design Agency	The organization performing the detailed design and/or analysis of a project or modification.(see IMP 342)
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 IMP 342)
ESM	LANL Engineering Standards Manual
FM	Factory Mutual, a nationally recognized testing laboratory.
FP	LANL Fire Protection Group
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 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
IPP	Institutional Policy and Procedure, a LANL requirements document
LAFD	Los Alamos County Fire Department
LMSM	LANL Master Specification Manual
NFPA	National Fire Protection Association
PD	Program Description, a LANL requirements document
UL	Underwriters Laboratories

3.0 CODES AND STANDARDS

3.1 General

A. Request for variances and exceptions from the requirements stated in the LANL Engineering Standards shall follow the process outlined in ESM Chapter 1 Section Z10. The LANL Fire Marshal, not the POC, may approve any variations and exceptions to this chapter of the ESM.

B. Codes of Record: The fire protection-related codes and standards in effect when a facility design commences shall be considered the "codes of record" and shall remain in effect for the life of the facility. Establishment and maintenance of the facility's design basis, including "codes of record" shall be in accordance with Section Z10. As determined by the LANL Fire Marshal, the current edition of the codes or standards applies to the facility modifications.

C. Online Codes and Standards: Access to selected online national codes and standards including IBC, IFC, NFPA, and UL are available to anyone with a LANL IP address or "smart card" at: http://library.lanl.gov/infores/stand/

3.2 LANL Contract Appendix G

A. Comply with the LANL Prime Contract.

B. CFRs: Comply with the latest edition all applicable CFRs including 10CFR851 which specifically invokes a number of NFPA codes and standards.

1. CFRs available at: *http://www.access.gpo.gov/nara/cfr/cfr-table-search.html#page1*

3.3 LANL Engineering Standards

A. Engineering Standards Manual (ESM), ISD 341-2[1]

1. ESM Chapter 1 Section Z10 has general requirements applicable to all discipline work including fire protection.

2. *Guidance: This Fire chapter has been subdivided into sections that allow for more convenient control of information. Section numbering generally follows the UNIFORMAT system promulgated by the Construction Specifications Institute (CSI) and further described in ASTM E1557.*

B. LANL Master Specifications Manual

1. Comply with the LANL Master Specifications Manual (LMSM) when writing and preparing a specification package, i.e., format, writing and editing, etc. *Guidance: The LMSM provides construction specifications that are referenced throughout the ESM. Specs are preferred over extensive drawing notes.*

[1] LANL IMP 341, "Conduct of Engineering," is the implementation requirement document for this manual. Refer to the ESM Introduction for statements of the purpose, scope and applicability of the ESM.

2. Number the specification sections in accordance with the CSI MasterFormat document, but do not renumber LANL Master Specs.

3. Comply with specifications in the ESM unless referenced in *italicized* text. When editing these specifications to suit the project, add job-specific requirements and delete only those portions that in no way apply. To seek a variance from applicable requirements, contact the ESM Fire Protection POC.

4. See ESM Chapter 1 Section Z10 for additional requirements.

C. LANL Standard Drawings and Details

1. Comply with standard detail drawings unless referenced in *italicized* text. Edit the details to reflect the particular details of the project, but obtain Fire Marshal approval when changing detail requirements.

D. LANL Drafting Standards Manual

1. Comply with the LANL Drafting Standards Manual when creating or revising drawings for facility projects.

E. The above manuals are available at: http://engstandards.lanl.gov/

3.4 DOE (Department of Energy) (Selected Orders, Guides, and Standards)

A. DOE O 420.1B, Facility Safety

B. DOE G 420.1-3, Implementation Guide for DOE Fire Protection and Emergency Services Programs for Use with DOE O 420.1B, Facility Safety[2]

B. DOE M 440.1-1, Explosive Safety Manual

C. DOE-STD-1066, Fire Protection Design Criteria

D. DOE STD-1088, Fire Protection for Relocatable Structures

Above directives available at http://www.directives.doe.gov/

3.5 Building Code

A. International Building Code (IBC) and the International Fire Code (IFC), editions as required and amended by ESM Chapter 16, IBC Program.

1. Refer to ESM Ch 16 Section IBC-GEN (App A, LBC) for LANL amendments to the IBC, including seismic design basis ground motion values.

B. Follow the most stringent among fire and life-safety requirements of the IBC, IFC, and New Mexico and LANL amendment to the IBC and NFPA 101-Life Safety Code[3].

[2] Replaced DOE G 440.1-5 in 2007.

1. Doing so shall be considered to have met the "life safety" requirements of OSHA (29 CFR 1910).[4]

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

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

3.6 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)

3.7 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/catalog/ or, for LANL net users, http://library.lanl.gov/infores/stand/

C. *Guidance: Fire Protection Handbook*

3.8 Society of Fire Protection Engineers

A. *Guidance: Fire Protection Engineering Handbook.*

3.9 XL Global Asset Protection Services (XL GAPS) (formerly IRI)

A. *Guidance: XL GAPS Guidelines manual*

4.0 CONSTRUCTION

4.1 General Building Construction Requirements

A. Fire resistance ratings for buildings shall be based on the IBC or 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 11(000).[5]

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[3] Per ESM Ch 1 Section Z10 subsection on Codes and Standards (driven by NSEP-TP-1)
[4] Basis: PD 1220.0, *Fire Protection Program*, Section 3.1.2, also J. Streit memo, (EMRef 24.) (**Note:** EMref refers to a Standards Program internal filing system for hard-to-find references.)
[5] DOE O 420.1B, "Facility Safety," Ch II 3.c (2), requires noncombustible construction for facility size limitations established by DOE-STD-1066-99. Either Type II requirement is considered a reasonable implementation, since neither has a fire resistive rating requirement for the (1) exterior bearing walls; (2) columns, beams, girders, trusses

4.2 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 Listed by Underwriters Laboratories (UL), Approved by FM Global (FM), or Listed by another nationally-recognized testing laboratory 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.*

4.3 Fire Areas

A. *Guidance: Larger 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*.

4.4 Fire Barriers

A. Because fire areas are basic to the fire analysis of a building, the fire barriers that separate fire areas shall be maintained throughout the life of the facility.

B. Where a wall or floor/ceiling is credited as a fire barrier, its design shall be 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.[6]

2. If fire barriers are utilized to segregate or minimize large (i.e., greater than $50M) property loss potentials within a structure, barriers shall have a fire rating of not less than three (3) hours.[4]

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

[6] DOE G 420.1-3, Implementation Guide Fire Protection and Emergency Services Program for use with DOE O 420.1B, *Facility Safety*, para 4.6.9 on FHAs

3. Certain types of occupancies within a structure shall be separated from other types of occupancies in the same structure to provide an increased level of life safety for the occupants of 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.

4.5 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, or until it is re-evaluated and downgraded by a fire protection engineer (LANL Fire Protection [FP] Group). To maintain good condition of a fire barrier, any openings/penetrations through it shall be appropriately protected.

B. Fire barrier penetrations of all types shall be appropriately sealed to maintain fire barrier integrity. 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 FP Group).

C. Ventilation Penetrations:

1. Ductwork penetrating a fire barrier (of greater than 1 hour fire resistance) shall be equipped with a fire damper in most cases. Fire damper installations shall be in accordance with manufacturers' instructions, maintaining the required gap around the damper to allow for thermal expansion without buckling the damper sides. While the exterior perimeter of the HVAC duct penetration through a fire barrier needs to have sufficient clearance per manufacturer's instructions for the fire damper to function correctly, the exterior opening must still be protected with a seal assembly. Also refer to SMACNA Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.[7]

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

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

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

[7] NFPA 90A, *Installation of Air Conditioning and Ventilating Systems*

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). Such mechanisms shall be UL Listed, FM Approved, or listed by another nationally recognized testing laboratory 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 using one of a variety of methods. Refer to UL Fire Resistance Directory, Volume II, or the FM Global Approval Guide, or the listing guide of another nationally recognized testing laboratory, for listings of fire rated penetration seal assemblies.
2. *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.*
3. Where structural steel penetrates a fire rated barrier, that configuration shall be reviewed by a fire protection engineer (LANL FP Group) to determine if additional fire protection measures are required. The steel can transmit significant heat from one side of the barrier to the other, potentially spreading fire.
4. Windows through a fire barrier shall be in accordance with NFPA 80, Standard for Fire Doors and Other Opening Protectives. *Guidance: Fire-resistant (wired) and other approved glass can be used in limited amounts. Shutters or spray systems can be used to protect window openings in the event of a fire. Guidance is available from the LANL FP Group.*
5. 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 FP Group.*

5.0 DESIGN DOCUMENTATION

5.1 Calculations

A. Refer to Subsection D4010, Sprinklers, 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. Existing Facilities: Fire alarm calculations (voltage drop, battery load calculations) are required whenever a fire alarm system is modified. Refer to Section 8.3 for associated requirements.

5.2 Sealing Construction Documents

See ESM Chapter 1 Section Z10 (*Design Output Submittals subsection).*

6.0 EQUIPMENT/PIPING IDENTIFICATION

A. Refer to NFPA 13 and Mechanical Chapter, Section D10-30GEN for requirements.

7.0 EXPOSURE AND NATURAL PHENOMENON HAZARDS PROTECTION

A. Adjacent Relocatable Structures: DOE-STD-1088, *DOE Standard on Fire Protection for Relocatable Structures,* 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 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 FP Group is available to provide additional guidance*.

C. NFPA 1144, *Standard for Protection of Life and Property from Wildfire,* shall be used to determine how to evaluate the degree of wild land fire hazard for a particular facility. DOE M 440.1-1 shall be used to determine special requirements for protection of explosives facilities from wild land fire exposure.

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 FP Group for guidance.

2. *Guidance: Wild Land Fire Exposure: 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. Also refer to the International Wildland-Urban Interface Code (ICC) for further guidance.

D. Lightning: All explosives facilities, all facilities with a replacement value of $3 million or more (structure and equipment), and facilities of significant programmatic importance shall be equipped with lightning protection in accordance with[8]:

- 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 $3M threshold, the determination of significant programmatic importance shall be made by Fire Marshal and facility and programmatic management prior to subcontracting for AE services. [9]

Also reference LANL Master Specification Sections 26 4100 series on lightning protection, and DOE M 440.1-1. For additional requirements refer to the ESM Electrical Chapter.

8.0 FIRE ALARM SYSTEMS

8.1 General

A. Design a fire alarm system[10] in every building or structure of such size, arrangement, or occupancy that a fire itself might not provide adequate occupant warning.[11]

B. 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 Group.

C. 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 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.*

[8] 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. $3M threshold from PD 1220 Section 3.1.3 as "directed" by DOE G 420.1-3 Section 4

[9] 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'

[10] 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.

[11] This fundamental requirement for occupant notification is from clause 9.6.3 of NFPA 101-2006

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).

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

1. Section 28 3100, *Fire Detection and Alarm* [use for all new systems]
2. Section 28 3110, *Fire Detection and Alarm -- Addition to Existing*

E. For new or extensively renovated facilities, provide addressable fire alarm systems.[12]

F. For additions or modifications to existing systems consult with the LANL Fire Protection Group 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.

G. 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.[13]
4. Area smoke or thermal detectors where required by any NFPA code or standard, the International Building Code, ASME A17.1 (elevators), or DOE O 420.1B. Note that with the 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 $50M) per DOE O 420.1B, DOE G 420.1-3, 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.
6. Connections to sprinkler waterflow alarm switches.
7. Connections to sprinkler system control valve and pressure supervisory devices.
8. Sounder and synchronized signal strobe combination notification appliances.

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[12] The LANL Fire Protection Group 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.

[13] Requirement for manually actuated initiating devices in NFPA 72 (part 5.13 in 2006) overrides any exceptions that may be provided in NFPA 101.

9. Elevator recall/shunt relays (if the building has an elevator) as required by ASME A17.1.
10. 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.[14]
11. Digital alarm communicator transmitter (DACT) to sent point-identified alarm, supervisory, and trouble signals to the LANL Central Station.
12. Conduit and GFE cable from the FACP to building's main telecommunications room.
13. Surge protection for line power circuits serving the fire alarm system.
14. Surge protection for initiation, notification, and signaling circuits that extend beyond the building or are otherwise exposed to lightning.

H. In general, each building that warrants a fire alarm system shall have its own fire alarm control panel.[15]

I. Digital alarm communicator transmitter (DACT) reporting format to the LANL Central Station shall be "Contact ID" capable of encoding specific point identification.[16]

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.[17]
3. Turn on all strobe lights throughout the building.

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[14] The LANL Fire Protection Group augmented the battery standby capability requirement in Secondary Power Supply clause of NFPA 72 (4.4.1.5 in 2006).

[15] 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.

[16] The LANL Fire Protection Group has standardized on the "Contact ID" reporting format because it is capable of transmitting initiating device level alarm information to the Central Station.

[17] Refer to Distinctive Evacuation Signal section in NFPA 72 (§6.8.6.5 in 2006).

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 central station 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 Group.
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 Central Station 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:

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.[18]

B. Design organizations (e.g. Architect/Engineer firms) shall provide performance specifications based on LANL Master Specification Section 28 3100 or 3110.

C. The fire alarm contractor 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 Group:

1. Shop drawings of the FACP indicating location of components, interconnection of components and connections to alarm initiating, indicating, and auxiliary circuits.

[18] Refer to NFPA 72 (4.3.2.1, 4.5.2.1 in 2006)

2. Fire alarm riser diagram showing new and existing alarm initiation circuits, alarm appliance circuits, input/output functions, and communications connections.[19] Show all new and existing fire alarm devices and the corresponding room numbers. Refer to Standard Drawing ST-D4020-1.
3. System input/output matrix showing the system actions in response to alarm, supervisory, and trouble conditions. Refer to Standard Drawing ST-D4020-1.
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.[20]
7. Battery load calculations for the FACP and any remote power supply panels and selection of proper battery size.
8. Audible alarm signal calculations 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.[21]
9. Selection of initiating, indicating, and auxiliary devices compatible with the FACP.
10. Record as-built drawings showing all changes to design documents.[22]

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.*

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[19] The fire alarm riser diagram and associated input-output matrix show the functional interconnections of initiating devices, notification appliances, and controlled systems.
[20] Lesson-learned from several previous fire alarm projects.
[21] Refer to part 7.4 of NFPA 72-2006.
[22] Accurate design and as-built documentation facilitates maintenance and future system modifications.

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 NFPA 72.[23] Use an inspection and testing form that is acceptable to the AHJ.[24]

B. Notify the LANL authority having jurisdiction (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.[25]

C. Provide "record of completion" upon successful acceptance test and inspection.[26]

D. Sprayed fire-resistant materials and smoke control measures are subject to the special inspection requirements of IBC Chapter 17 and ESM Chapter 16-IBC Program.

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, NFPA 86, NFPA 86C, and NFPA 86D.
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, NFPA 493, NFPA 497, and NFPA 499. Also follow UL/ANSI 913 where applicable.
4. **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 and NFPA 15 annex.
5. **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.

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[23] Refer to Chapter 10, Inspection, Testing, and Maintenance, in NFPA 72-2006.
[24] Refer to Records in NFPA 72 (§10.6 in 2006)
[25] Approvals and documentation per NFPA 72 (§4.5.1 in 2006)
[26] Concept and form per NFPA 72 (§4.5.1.3 in 2006).

6. **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.

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

10.0 FIRE PROTECTION SYSTEM/STRUCTURE/COMPONENT (SSC) DESIGN AND INSTALLATION

A. **Design Criteria**. Follow DOE-STD-1066-97, Fire Protection Design Criteria, DOE M 440.1-1 for explosive facilities, and NFPA codes, standards, and recommended practices. Also review the FM Global Loss Prevention Data Sheets, and the XL GAPS (formerly Industrial Risk Insurers) Guidelines for additional requirements.

B. **Preparing Calculations**. 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.

C. **Preparing SSC Drawings**. Comply with the LANL Drafting Standards Manual and the applicable NFPA Code or Standard.

D. **System Impairment Process**. Follow Criterion 733, Fire Protection System Impairment Control Program, in the LANL Operations and Maintenance Manual (OST 230-05-01).

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

11.0 LIFE SAFETY CONSIDERATIONS

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

B. For explosives facilities, comply with additional life safety requirements in DOE M 440.1-1.

C. 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.

D. *Life safety feature guidance:*

1. *Once the occupancy has been identified, IBC and NFPA 101 specifies 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 (LANL RESPONSIBILITIES)

A. Coordinate with LANL FP Group to provide documentation to LAFD describing a new facility or changes to an existing facility so that the Pre-Fire Plans can be kept up to date. *Guidance: The Los Alamos County Fire Department (LAFD) develops and maintains Pre-Fire 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 6430.1A, "General Design Criteria" for new construction, DOE O 420.1B, Ch. II 3.c (10), 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-Fire 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 fire fighting 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 Group and/or Emergency Operations (EO) to provide up-to-date information on any changes to an existing facility's physical hazards or hazard configuration, so that Pre-Fire 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, coordinate with the LAFD through EO 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 Run Sheets shall also be changed. Coordinate with Facility Management for evacuation plans. Coordinate with EO for Run Sheets.[27]

13.0 SITE FIRE PROTECTION WATER DISTRIBUTION

A. Refer to the Civil Chapter, Subsection G3010, for site requirements.

[27] LIR 403-00-01, Los Alamos National Laboratory Emergency Management, and LA-12900 referenced in LIR

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 and NFPA 230.
2. Gloveboxes and Filter Plenums. Follow DOE-STD-1066, *Fire Protection Design Criteria*, 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, NFPA 318, and NFPA 801.
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 M 440.1-1, Explosives Safety Manual, and NFPA 495.
5. Paint Spraying/Coating. Follow NFPA 30, NFPA 33 and NFPA 34.
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, and FM Global 5-32 for computing and data processing occupancies; follow NFPA 76 for telecommunications occupancies.

D4010 SPRINKLERS

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 Section D4090, Other Fire Protection Systems.

2.0 DESIGN REQUIREMENTS

A. Provide a complete automatic fire suppression system for a new or modified structure where the maximum possible fire loss (MPFL) exceeds $3 million[28] (structure and equipment replacement, post-fire clean-up, and post-fire recovery costs) or where determined necessary by the LANL FP Group due to the mission importance of the structure. Such a suppression system need not be an automatic fire sprinkler system.

1. FP Group decision should be made prior to subcontracting AE services.

B. The minimum design area for an automatic sprinkler system shall be 1500 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 5 psi below the water supply curve. Final water supply curve shall be after required 500 gpm hose streams and friction loss to the base of the riser have been deducted.

[28] $3M threshold from PD 1220 Section 3.1.3 as "directed" by DOE G 420.1-3 Section 4

C. Provide a hydraulically designed automatic sprinkler system for protection of an NFPA 13 ordinary hazard Group 2 occupancy as a minimum, except as approved otherwise by the LANL Fire Marshal.

D. Provide a separate fire protection service line inside the building.

E. 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.

F. 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 the same requirements in NFPA for combustible concealed spaces.

G. Provide sprinkler system with a minimum number of control valves. Provide outside stem and yoke (OS&Y) valves with a tamper switch.

H. Sprinkler systems shall be monitored by a fire alarm panel in accordance with NFPA 72 and shall report locally and to the LANL Central Alarm Station.

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

J. The LANL FP Group will provide water flow test data upon request.

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

L. 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.

M. Provide an initiating alarm device (sprinkler system flow or pressure switch) for each area of the building protected by sprinklers, to assist the Fire Department in determining the location of a fire during an emergency.

N. Refer to the following LANL Standards for additional requirements:

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.

D4020 STANDPIPES

This section provides requirements/guides for standpipe system piping downstream of the base of the system riser.

A. Provide standpipe systems when required by the NFPA Codes or the International Building Code. 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.[29]

B. Comply with requirements of IBC and NFPA 14 (Standard for the Installation of Standpipe, Private Hydrant, and Hose Systems). Consultation with the LANL FP Group 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.

C. Design standpipe systems in accordance with IBC and NFPA 14.

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 FP Group prior to purchasing and installation.

B. *Guidance: Fire extinguishers are typically furnished by the using group and installed by LANL's Support Services Subcontractor. Alternately, fire extinguishers may be furnished by the Project for new facilities.*

C. Refer to LANL Master Specification 10 4400, Fire Protection Specialties, for additional requirements.

D4090 OTHER FIRE PROTECTION SYSTEMS

1.0 SPECIAL 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.

[29] DOE O 420.1B, Ch II 3.c(9), requires appropriate equipment to facilitate effective intervention.

C. Refer to the following LANL Standards for additional requirements:

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
4. Chapter 2 Section D4010, Sprinklers (above), as applicable.

ENDNOTES

In footnotes, EMref refers to an ESM maintainer system for managing hard-to-find reference copies.