D4010 FIRE SUPPRESSION AND SPECIAL EXTINGUISHING SYSTEMS

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RECORD OF REVISIONS

Rev.	Date	Description	POC	OIC
0	06/29/2023	Extracted from D40 Rev 6 (Subsections D4010 and D4010.50). Moved standpipe systems to its own subsection and moved special hazard systems into the main D4010 document. Changed Fire Protection Group (ES-FP) to Fire Protection (FP) Office. Provided guidance for preliminary design and installation/shop drawings. Added shop drawing requirements. Added qualification requirements for designers and shop drawing technicians. Provided a local policy for fire department connection (FDC) location. Reinforced that the applicable codes are to be consulted for sprinkler system requirements, not the ESM. Deleted unnecessary repetition of DOE requirements. Clarified definition of a sprinkler system and prohibited new antifreeze systems. Added requirements for privacy booths. Created a fire pump section with requirements for water supply reliability. Added installation and agent selection requirements for special hazard suppression systems. Specified a standard releasing panel.	Keenan Dotson, *FP*	Michael Richardson, *ES-DO*

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

The Los Alamos National Laboratory engineering standards are available at https://engstandards.lanl.gov.

D4010 FIRE SUPPRESSION AND SPECIAL EXTINGUISHING SYSTEMS

This section provides requirements for the planning, preliminary design, shop drawing preparation, installation, and final system acceptance. Refer to the Fire Chapter 2, Section D40GEN for general requirements applicable to fire suppression and special extinguishing preliminary design (typically performed in conceptual or main design for new facilities) and related fire protection and life safety topics. Additional testing requirements are in Section D4050, *Inspection, Testing, and Commissioning*.

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

1.0 GENERAL

Note: Engineering/preliminary design of automatic sprinklers and other suppression or extinguishing system is prepared by a design professional (i.e., engineer of record) who specifies the performance criteria, required equipment locations, areas of coverage, interfaced systems, etc. This typically occurs in the Title II main (permitted) design package for new facilities. A fire protection engineering technician with the subcontracted vendor/installer prepares installation documentation (shop drawings) based on the engineering/preliminary design, as a deferred (Title III) design package.

For LANL internal design efforts, the engineering/preliminary design should be developed during project planning (Title I) and incorporated into the project's requirements and criteria document (RCD), construction specifications, Exhibit D, and/or other planning and scope documents. During Title II design package development, the project's fire protection engineering technician prepares new shop drawings or clouds the existing, as-built shop drawings.

1.1 Preliminary Design

A. Preliminary or engineering design documents for new or extensively modified fire suppression or special extinguishing systems shall be produced by — or with the supervision of — a fire protection engineer (Requirement 2-0233).

B. The design agency (i.e., engineer of record) shall provide performance specifications based on the applicable Los Alamos National Laboratory (LANL) Master Specification Division 21 section (Requirement 2-0242) for shop drawing preparation and/or system installation.

C. LANL-produced designs are generally exempt from stamping/sealing and professional engineering registration requirements, unless required by another code, standard, or law. See Ch. 1, *General Requirements*, Z10 for details.

1.2 Fire Department Connection (FDC)

A. Fire department connections (FDCs) shall be located on the exterior wall of the building adjacent to the fire department access roadway from the direction of approach of the assigned primary responding fire station (Requirement 2-0237).

B. The FDC shall be visible from the fire department access roadway for minimum of 50 feet (continuously and without obstructions) unless approved by the Fire Protection (FP) Office (Requirement 2-0237).

2.0 AUTOMATIC SPRINKLER SYSTEMS

This section provides requirements and guides for automatic 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 4.0, *Special Fire Extinguishing Systems*, below.

A. Provide a complete automatic sprinkler system for a new or modified structure where (Requirement 2-0121):

1. Required by the International Building Code (IBC), International Fire Code (IFC), National Fire Protection Association (NFPA) 1, NFPA 101, or standards applicable to the project.
2. The maximum possible fire loss (MPFL) exceeds $5.9 million (baselined on CY 2018 values) (structure and equipment replacement, post-fire cleanup, and post-fire recovery costs).
3. The size of the protected structure exceeds 5,000 square feet of floor area.
4. Determined necessary by the LANL FP Office due to the mission importance of the structure.
5. Required by a safety basis document (e.g., to prevent loss of safety functions or provide defense-in-depth).
6. Required in response to significant life safety hazards.

Guidance: The LANL FP Office's decision on the need for automatic fire suppression system protection should be made prior to subcontracting design services. For example, a suppression system need not be an automatic fire sprinkler system if approved by the LANL fire marshal.

B. Fire suppression shall *not* be required in:

1. Outside explosive or ammunition storage magazines (Requirement 2-0262).
2. Privacy pods that are less than 24 square feet, are not subject to storage, do not extend to the ceiling, are spaced at least 4 feet apart, and do not obstruct sprinkler heads in the space. (Requirement 2-0263).

Note: The internally-unprotected privacy pod cannot obstruct sprinkler spray pattern development in the room. If the top of the privacy pod is less than 18 inches vertically from the elevation of the sprinkler head deflector, contact the LANL FP Office to evaluate.

C. Sprinkler systems shall be a hydraulically designed automatic sprinkler system per NFPA 13, *Standard for the Installation of Sprinkler Systems* (Requirement 2-0124).

1. The minimum required NFPA 13 hazard classification shall be based on the project-specific details and criteria, IBC, IFC, NFPA 1, NFPA 101, and any applicable industry- or occupancy-specific standards and will be documented by the project requirements document (Requirement 2-0125).
2. Minimum hose stream allowance shall be 250 gpm for systems without fire pumps and 500 gpm for systems with fire pumps[1] (Requirement 2-0126).

[1] DOE-STD-1066-2016 Section 4.2.7.1.2 requires a fire protection water distribution system to be capable of supplying a maximum combined demand that includes a 500-gpm hose stream allowance. This applies to the water distribution system and not any individual sprinkler system. Only the water distribution system must be capable of supporting a 500-gpm hose allowance in addition to other demands at or above 20 psig residual pressure. Use 1066 edition per Section D40GEN.

3. The LANL fire marshal will require an increase in the minimum required hazard classification and/or outside hose stream allowance when (Requirement 2-0127):
    a. The protected facility could change to a more hazardous use or occupancy classification.
    b. The protected facility is a nuclear facility (below or above Hazard Category 3).
    c. The protected facility is of high value.
    d. The protected facility is important to LANL mission or operations.
    e. The protected facility or project fire hazard analysis (FHA) prescribes it.
    f. There are other reasons to provide additional capacity in the infrastructure or additional protection to property (e.g., elevated highly protected risk (HPR) levels of fire protection).
4. Light Hazard occupancy classification shall be permitted only for business occupancies without hazardous materials in buildings incapable of supporting change to a more hazardous use or occupancy (Requirement 2-0251).
5. Standard response sprinkler heads shall be provided unless quick response sprinklers are required for the occupancy or use (Requirement 2-0128).

    Quick response sprinklers may be permitted to avoid installation of a fire pump.
6. Hydraulically designed systems shall be designed at least 10 psig or 10 percent (whichever is greater) below the water supply curve (Requirement 2-0129).
7. The LANL FP Office will provide waterflow test data upon request. Where recent data is unavailable, a hydrant flow test may be coordinated with Utilities and Infrastructure Water.

D. Provide a separate fire protection service line (i.e., lead-in) into the building, except as approved otherwise by the LANL fire marshal (Requirement 2-0130).

E. Each system riser and floor control assembly shall be treated as individual sprinkler systems, even when supplied from a shared supply main, manifold, or primary building system riser (Requirement 2-0238).

F. Where connected to a potable water source, provide backflow preventers (BFP) on all new fire protection system risers and any downstream foam or anti-freeze solution containing fire protection subsystems (Requirement 2-0131).

1. The standardized fire protection backflow preventers are:
    a. FEBCO, Model LF880V
    b. Wilkins, Model 475V
2. A catastrophic drain of one pipe size larger in diameter than the BFP shall be provided at the relief valve, discharging to the exterior of the building, but also including a minimum 1” nuisance drain plumbed to a suitable sanitary floor drain (Requirement 2-0267).
3. For the forward-flow test, the backflow preventer shall be a test header with at least one 2½-inch hose valve (National Standard Thread) per 250 gpm of system demand water flow, unless approved otherwise by FP (Requirement 2-0206).
4. Refer to the ESM Chapter 6, Mechanical; Section D20; Subsection, Cross Connection Control, for additional requirements.

G. New antifreeze sprinkler systems—in new facilities or additions in existing facilities—shall not be installed (Requirement 2-0239).

H. Existing antifreeze sprinkler systems shall be filled with a pre-mixed freeze protection solution designed and listed for use in wet pipe sprinkler systems approved by LANL (Requirement 2-0132).

Note: At the time of writing, the approved solution is Lubrizol Freezemaster. The approved antifreeze solution is standardized with consensus of the FP Office, Maintenance and Site Services, and facility stakeholders. Tyco LFP and LFP+ was previously used but became difficult to obtain.

I. Heat trace systems provided for branch lines of automatic sprinkler systems shall be supervised by the building fire alarm system by a listed system per IEEE 515.1 and the listing requirements. For heat traces only provided for mains, only supervision of power is required (Requirement 2-0268).

J. Where concealed spaces are formed by non-combustible construction but contain significant levels of 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 13 for combustible concealed spaces (Requirement 2-0133).

K. Provide floor control assemblies or separate system risers to zone individual floors of buildings controlled by outside stem and yoke (OS&Y) valves with a tamper switch. Confirm the minimum number of control valves and system zones with the LANL FP Office (Requirement 2-0134).

L. Sprinkler systems shall be monitored by a local fire alarm panel that reports remotely to the LANL Proprietary Supervising Station (i.e., Emergency Operations Console (EOC)) (Requirement 2-0135).

M. 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 (Requirement 2-0136).

N. Prepare fire suppression system drawings in accordance with the LANL Drafting Standards Manual and applicable NFPA installation standards (Requirement 2-0137).

O. Provide a waterflow alarm switch for each floor and unique area of the building protected by sprinklers, as determined in consultation with FP, to assist the fire department in determining the location of a fire during an emergency (Requirement 2-0138).

Separate fire areas, isolated rooms without interior doors, concealed spaces, shafts, high-value equipment rooms, and hazardous spaces should be considered for independent zoning so that the location of the flow can be quickly found to prevent extended sprinkler discharges or greater manual firefighting efforts, which could result in more extensive facility damage and loss of equipment.

P. Waterflow alarm switches shall be pressure-type with adjustable pneumatic retard or vane-type with adjustable retard. Use of retard chambers with alarm switches is not permitted. Retard chambers are permitted for mechanical water gongs (Requirement 2-0269).

Q. Hazard Category 1, 2, and 3 Nuclear Facilities:

1. 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 (Requirement 2-0139).

2. Quality assurance shall also comply with ESM Chapter 1, General, and SD330, *LANL Quality Assurance Program* (or Exhibit H for subcontracts). Comply with the editions of ASME NQA-1 and NQA-1a cited therein.

3. Seismic design shall comply with ESM Chapter 5, Structural. For high-hazard nuclear (i.e., SDC-3), Chapter 5, Section III must be met.

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)*.

R. The anticipated operation—or inadvertent operation and failure—of the sprinkler system must not result in the loss of function of designated SC or SS (nuclear) systems, structures, or components (SSCs) (Requirement 2-0140).

S. Refer to the following LANL Standards Master Specifications (here (Requirement 2-0146):

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*.

3.0 STANDPIPE SYSTEMS

A. Requirements for standpipe systems piping downstream of the base of the system riser:

1. Provide standpipe systems when required by NFPA codes and standards 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 (Requirement 2-0143).
2. Design and install standpipe systems in accordance with IBC and NFPA 14, *Standard for the Installation of Standpipe, Private Hydrant, and Hose Systems* (Requirement 2-0144).
3. Consultation with the LANL Fire Protection Office on the type and performance of a new standpipe system is required, with final approval by the LANL fire marshal (Requirement 2-0145).

4.0 FIRE PUMPS

A. Fire pumps shall be sized to meet the system demand without exceeding 140% of its rated capacity (Requirement 2-0270).[2]

B. Where fire pumps are provided, the water distribution system or an alternate water source shall provide at least 10 psi static pressure to the top line of sprinklers of the sprinkler system (Requirement 2-0271).

5.0 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

[2] This may be reduced to 120% by FP for high-value, critical, and similar kinds of facilities requiring improved protection from fire risk.

detection, extinguishing agent, and extinguishing system design for the hazard (Requirement 2-0147).

Guidance: The IFC permits use of alternative extinguishing systems (alternative to automatic sprinklers) where approved by the LANL fire marshal. NFPA codes and standards have similar provisions.

B. Follow, as applicable, NFPA 11, 11A, 12, 13, 15, 16, 17, 17A, 69, 750, 2001, and other applicable NFPA codes, standards, and recommended practices (2-0148).

Guidance: The requirement for drawings or plans for special fire extinguishing systems is, in general, left to discretion of the authority having jurisdiction (AHJ) (i.e., the LANL fire marshal). Consult with the LANL FP Office when developing requirements or design documentation.

1. Do not install new Halon 1301 systems; maintain any existing systems to NFPA 12A (Requirement 2-0149).
2. Do not install carbon dioxide systems in occupiable spaces or outside of equipment (Requirement 2-0252).
3. Do not install FM-200 and Novec 1230 systems for applications for which other agents would be effective and reasonable priced (Requirement 2-0253).

Carbon dioxide systems are not safe to use in spaces that could possibly be occupied, as the resulting atmosphere is fatal. FM-200 and NOVEC 1230 may be phased out in the future due to global warming and per- and polyfluoroalkyl (PFAS) "forever chemical" concerns.

4. All gaseous extinguishing system installations and modifications shall include compartment sealing as part of the project scope (Requirement 2-0254).
5. Extinguishing system equipment (e.g., agent cylinders and control equipment) shall be in a dedicated area or room of a size to permit maintenance and replacement of equipment without extensive disassembly of the system (Requirement 2-0255).
6. Where extinguishing system agent cylinders and control equipment must be located within the protected area, the equipment area shall be protected from fire hazards with fire-rated construction (Requirement 2-0256).
7. Alteration of spaces protected with special fire extinguishing systems shall require an analysis of possible effects to the system due to reconfiguration of protected volumes, new leakage paths, and impacts of new equipment or hazards (Requirement 2-0257).
8. Provide a Fike SHP-PRO conventional releasing panel unless approved otherwise by FP (Requirement 2-0272).

C. Follow, as applicable, the following LANL Standards Master Specifications available here (Requirement 2-0150).

- Master Specification Section 21 1326, *Deluge Fire Suppression Sprinkler Systems*
- Master Specification Section 21 2200, *Clean Agent Fire-Extinguishing Systems*

6.0 INSTALLATION DOCUMENTATION (SHOP DRAWINGS)

A. Externally produced fire suppression/extinguishing system shop drawings shall be prepared by fire protection subcontractors who are experienced with respect to proper layout, application, installation, and testing of such systems (Requirement 2-0241).

B. Subcontractor technicians preparing installation documentation (shop drawings) for fire suppression or special extinguishing systems shall be qualified (Requirement 2-0234):

1. Wet-pipe or dry-pipe automatic sprinkler systems of Light Hazard or Ordinary Hazard Group I or II; and standpipe systems: National Institute for Certification in Engineering Technologies (NICET) Level III (minimum).
2. All other automatic sprinkler systems, including high rack/pile storage, and all special extinguishing systems: NICET Level IV.
3. Shop drawings for any system may also be prepared by a registered fire protection engineer.

C. Shop drawings shall be stamped by a registered fire protection engineer when required by ESM Ch. 1 Section Z10.

D. LANL-produced shop drawings are generally exempt from stamping/sealing and professional engineering registration requirements—unless required by another code, standard, or law. See ESM Ch. 1 Z10 for details.

E. Material and equipment document packages shall be provided for all shop drawings, including modifications to existing systems (new parts only) (Requirement 2-0243).

F. Shop drawings shall include section details and drawings with structural member information for all installations with exposed ceiling/roof structure, cloud-ceilings, soffits, or other architectural features where the ceiling elevation varies throughout spaces (Requirement 2-0244).

G. Pre-engineered fire suppression and special extinguishing systems do not require shop drawing submittals when both of the following are true (Requirement 2-0245):

1. The system protects small rooms, equipment, and similar spaces under 150 square feet.
2. Detection and actuation are not operated by means of electrical or fire alarm-signaling systems.

H. Electrical and fire alarm signaling systems associated with fire suppression and special extinguishing systems shall conform to the requirements of D5037 (Requirement 2-0273).

I. Detailed hydraulic/flow calculations are not required for any pre-engineered fire suppression and special extinguishing systems (Requirement 2-0274).

J. The manufacturer's design, installation, and maintenance manuals shall be provided for FP review, approval, and acceptance of pre-engineered fire suppression and special extinguishing systems (Requirement 2-0246).