D5037 FIRE ALARM SYSTEMS

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RECORD OF REVISIONS

Rev.	Date	Description	POC	OIC
0	06/29/2023	Extracted from combined D40 r6 document [Subsection 8.0 Fire Detection and Alarm (D5030.90)]. Incorporated key requirements from LANL Master Specification Section 28 4600. Changed Fire Protection Group (ES-FP) to Fire Protection (FP) Office. Clarified difference between fire alarm design and installation (shop) drawings in general requirements. Added requirements for equipment accessibility for maintenance. Added timeline for submittals, review, and coordination for testing. Provided additional requirements and guidance for providing a fire alarm system, and where to locate fire alarm control units and annunciators. Specified standard fire alarm panel manufacturers.	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

D5037 FIRE ALARM SYSTEMS

Scope: Section D5037, *Fire Alarm Systems*, provides requirements for the planning, preliminary design, shop drawing preparation, installation, and final system acceptance.

Refer to the Chapter 2, Fire, Section D40GEN, for general requirements applicable to fire alarm system 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 D4050, *Inspection, Testing, and Commissioning*.

1.0 GENERAL

Note: Engineering/preliminary design of fire alarm systems design is prepared by a design professional (i.e., engineer of record) according to the specification of 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. The fire alarm or 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. As part of the Title II design package, the project's fire protection engineering technician prepares new shop drawings or, when as-built shop drawings exist, clouds them to indicate modifications needed. *Guidance: The native as-built drawing files are stored and checked in and out by Engineering Services (ES) Division, Facility Engineering (ES-FE).*

1.1 Preliminary Design

A. Preliminary or engineering design documents for new or extensively modified fire alarm systems shall be produced by or with the supervision of a fire protection engineer (Requirement 2-0264).

B. The design agency (i.e., engineer of record) shall provide performance specifications based on the project's version of LANL Master Specification, Section 28 4600 (Requirement 2-0089) 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 General Requirements

A. Provide a fire alarm system if required by the International Building Code (IBC), International Fire Code (IFC), National Fire Protection Association (NFPA) 101, *Life Safety Code,* NFPA 1, *Fire Code*, or project-applicable codes and standards based on use, operations, and occupancy classification (Requirement 2-0058).

B. Provide a fire alarm system in every building or structure of such size, arrangement, or occupancy that a fire itself might not provide adequate warning to occupants (Requirement 2-0059).

Guidance: Small office trailers and storage buildings do not require fire alarm systems since the products of combustion typically provide sufficient warning of an incipient fire and occupants have access to exits directly or through fire-rated corridors. Buildings

large enough to require fire suppression systems will be required to be provided with fire alarm systems.

C. Provide a fire alarm system where the facility is provided with fire suppression or detection systems, occupant emergency notification systems, or fire safety functions, or when there are no reliable means to report emergency conditions[1] (Requirement 2-0247).

Guidance: Fire alarm systems are not required in all Los Alamos National Laboratory (LANL) buildings but are provided in a graded approach based on applicable codes and standards, fire hazard, risk to occupants, property protection requirements, etc. Where the fire alarm system is a nonrequired system (by code), there is flexibility in the features provided if NFPA 72 installation standards and IBC/IFC performance criteria are met (IBC/IFC Section 901.4.2). It is not required to provide pull stations at every single exterior door from a facility, for example. The features necessary to meet the fire protection objectives should be provided.

D. Design fire alarm system to meet this chapter of the LANL Engineering Standards Manual and the applicable requirements of the following codes and standards (Requirement 2-0060):

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)

E. Use the materials and installation methods described in the following LANL Master Specification sections (Requirement 2-0061).

1. Section 28 4600, *Fire Detection and Alarm*
2. Section 26 0533, *Raceways and Boxes for Electrical Systems*
3. Section 27 1000, *Structured Cabling*

F. For new or extensively renovated facilities, provide addressable fire alarm systems, unless otherwise approved by the Fire Protection (FP) Office (Requirement 2-0062).

Guidance: Coordinate fire alarm system selection with the LANL FP Office.

G. Consult with the LANL FP Office to determine fire alarm system features. Record of this consultation shall be retained by the project (Requirement 2-0063).

H. Provide fire alarm systems with the following Nationally Recognized Testing Laboratory (NRTL)-listed fire alarm components as required by the IBC, IFC, NFPA 1, NFPA 101, NFPA 72, and fire protection objectives (Requirement 2-0064):

1. Fire alarm control unit (FACU) to initiate sequences of operation for fire detection, notification, building system control, and fire suppression functions (Requirement 2-0065).

[1] A fire alarm system is not required to be provided strictly due to presence of stand-alone detection systems for elevator safety functions or air handling unit shutdown, where permitted by the codes. Reliable means of emergency notification includes hardline telephones or areas where radios are required to be carried.

2. Conduit and wiring to connect the FACU to alarm initiating devices, notification appliances, and auxiliary equipment (Requirement 2-0066).
3. Manual fire alarm station at each exit from each floor (Requirement 2-0067).
4. Area smoke or thermal detectors where required by any NFPA code or standard, the IBC, ASME A17.1 (elevators), DOE O 420.1C, fire hazard analysis (FHA), or project requirements. (Requirement 2-0068).

   Property protection guidance: Area smoke or thermal detection may be required throughout a fire area for fire loss prevention or as part of a redundant fire protection system required for the protection of a large property loss potential (greater than $177 million baselined to CY 2018 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 structures, systems, and components (SSC) 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 (Requirement 2-0069).
6. Connections to sprinkler waterflow/pressure alarm switches (Requirement 2-0070).
7. Connections to sprinkler system control valve and pressure supervisory devices (Requirement 2-0071).
8. Sounder and synchronized signal strobe combination notification appliances (Requirement 2-0072).

   Guidance: Strobes are required by the IFC in public, common, and shared-use spaces. Employee work areas are exempt as long as 20 percent spare capacity is provided on notification appliance circuits; however, it is recommended that a percentage (e.g., 10 percent) of employee work areas are provided strobes because space use evolves and retrofit strobe installation is costly.
9. Supervision for Knox Box, provided as government furnished equipment (GFE), and as specified by the LANL fire marshal) (Requirement 2-0073).
10. Elevator recall/shunt relays (if the building has an elevator) as required by ASME A17.1 (Requirement 2-0074).
11. Fire/smoke door releasing functions (Requirement 2-0075).
12. Battery standby capable of operating the fire alarm system under maximum standby load (system functioning in a non-alarm condition with operating supervisory and trouble signals) for 24 hours, and at the end of that period operating all alarm notification appliances for no less than 10 minutes (Requirement 2-0076).
13. Digital alarm communicator transmitter (DACT) to send point-identified alarm, supervisory, and trouble signals to the LANL Proprietary Fire Alarm System (Requirement 2-0077).
14. Conduit and GFE cable from the FACU to building's main telecommunications room (Requirement 2-0078).
15. Manual transfer switch and receptacle powered by a different branch circuit or panel at the fire alarm control unit and any supplementary panels provided with independent power to support alternative power connections during outages (Requirement 2-0079).
16. Surge protection for line power circuits serving the fire alarm system, and surge protection and/or isolation modules for initiation, notification, and signaling

circuits that extend beyond the building or are otherwise exposed to lightning (Requirement 2-0080).

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 (Requirement 2-0081).
18. FACUs shall be in a conditioned space that is readily accessible for emergency forces and off-hours repair runners. This is typically the main entrance lobby or vestibule for the building (Requirement 2-0259).
19. Remote annunciators shall be located at the primary entrance, where the FACU must be located elsewhere due to poor space conditioning, obstruction of egress, or other issues (Requirement 2-0260).
20. Additional remote annunciators shall be provided in fire command centers, operations centers, and separate fire areas of the building (Requirement 2-0261).

I. Each building that requires a fire alarm system shall have an independent fire alarm control unit. For building complexes or buildings with auxiliary structures, other arrangements may be permitted with LANL Fire Protection Office approval, considering complexity, reliability, and size of initiating device and notification appliance circuits/zones (Requirement 2-0082).

J. Digital alarm communicator transmitter (DACT) reporting format to the LANL Proprietary Fire Alarm System shall be Contact ID capable of encoding specific point identification (Requirement 2-0083).

K. Fire alarm control units shall be by Notifier or Edwards Signaling models approved by FP (Requirement 2-0266).

2.0 FUNCTIONAL REQUIREMENTS FOR ADDRESSABLE SYSTEMS

A. The system shall identify any abnormal condition and log each condition into the system database as an event (Requirement 2-0084).

1. The system shall automatically display the first event of the highest priority by type on the control unit. 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 unit.

B. Operation of any alarm-initiating device shall automatically (Requirement 2-0085):

1. Update the control/display as described above.
2. Activate all alarm strobe lights throughout the building, fire area, or designated evacuation zone.
3. Sound all audible devices throughout the building, fire area, or designated evacuation zone (three-pulse temporal tone and any textual notification for voice evacuation systems).
4. Visually and audibly annunciate the alarm condition at the fire alarm control unit.

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 the associated emergency control functions and auxiliary devices as required by applicable codes, standards, and project design documents.

C. Activation of a supervisory signal-initiating device shall (Requirement 2-0086):

1. Update the control/display as described above.
2. Visually and audibly annunciate the supervisory condition at the fire alarm control unit.
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 unit. Any opens, grounds, or derangement of system wiring and shorts across alarm horn/strobe wiring shall automatically (Requirement 2-0087):

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 FACU. The visual indication shall remain on until the trouble condition is repaired.

3.0 INSTALLATION DOCUMENTATION (SHOP DRAWINGS)

A. External (subcontractor) fire alarm technicians preparing shop drawings shall be experienced with respect to proper layout, application, installation, and testing of fire alarm systems (Requirement 2-0088).

B. External (subcontractor) fire alarm technicians shall be at a minimum, Level III certified by National Institute for Certification in Engineering Technologies (NICET) for fire alarm systems and factory trained for the fire alarm control unit (FACU) to be installed on the project (Requirement 2-0090).

C. The schedule for the review of shop drawings, materials and equipment, site-specific software (program), red-lined, and as-built drawings shall follow Subsection 6.0 (Requirement 2-0248).

D. The fire alarm technician shall ensure the completeness and correctness of the fire alarm system installation documentation by preparing and submitting the following for review by the LANL FP Office (Requirement 2-0091):

1. Shop drawings of the FACU 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. 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 and indicate labeling of each fire alarm system conductor.
6. Conductor size calculations for each alarm initiating, indicating, and auxiliary circuit. Limit voltage drops so they do not exceed the FACU manufacturer's limitations for the most remote device on each circuit. New and revised voltage drop calculations shall be by the point-to-point method.
7. Battery load calculations for the FACU 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 an alarm signal at least 15 A-weighted decibels (dBA) above ambient at all locations, but not over 110 dBA at any location.
9. Selection of initiating, indicating, and auxiliary devices compatible with the FACU.
10. As-built drawings showing all changes to design documents.

4.0 INSTALLATION

A. Install fire alarm systems in accordance with National Electrical Contractors Association (NECA) 305, *Standard for Fire Alarm System Job Practices* (ANSI) (Requirement 2-0092).

B. All fire alarm devices, cards, modules, and appliances shall be accessible for inspection, testing, and repair without disassembly or removal of building components, structure, utilities, or finishes (Requirement 2-0240).

C. A clear path that is a minimum of 22 inches wide and 6 feet, 8 inches high shall be provided for access to control equipment along the working-walking surface (Requirement 2-0240).

D. The fire alarm control unit (FACU) digital alarm communicator transmitter (DACT) will be connected as follows (Requirement 2-0093):

1. The installer shall run three telecommunication cables, provided by LANL (currently CAT 5E), from the DACT to the telecommunications room/closet indicated in the design drawings.
2. The DACT will be connected to two separate dedicated telephone lines (numbers). Submit a request for the phone numbers to the Fire Protection Office's Fire Alarm Team. Telecommunications on- and off-site are moving away from analog lines. The medium and technology used for the FACU DACT signal reaching the LANL Proprietary Supervising Station is subject to change.

5.0 ACCEPTANCE TESTING AND INSPECTION

Note: *All fire alarm systems at LANL that interface with other building, fire protection, or life safety systems are tested by basic, end-to-end integrated system testing and are to be commissioned in accordance with the project commissioning plan. Follow D4050, Inspection, Testing, and Commissioning, for additional fire protection commissioning and integrated system testing requirements.*

A. Inspect and test the installed fire alarm system in accordance with the project's version of LANL Master Specification, Section 28 4600, *Fire Detection and Alarm,* and NFPA 72 (Requirement 2-0094).

B. The submittal schedule for revised shop drawings (red lines) and site-specific software and coordination of resources for pre- and final acceptance testing shall follow Subsection 6.0 (Requirement 2-0248).

C. For required preliminary and final acceptance testing, use a Fire Alarm Test Plan and Inspection and Testing Form compliant with NFPA 72 requirements acceptable to the authority having jurisdiction (AHJ) (Requirement 2-0095).

D. Notify the LANL AHJ (fire marshal) 10 days in advance of the final acceptance testing and inspection. Final acceptance inspection and testing must be witnessed by the LANL AHJ. 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 (Requirement 2-0096).

E. Provide the completed Testing and Inspection Form and Record of Completion in accordance with NFPA 72 upon successful acceptance test and inspection (Requirement 2-0097).

Guidance: Testing and commissioning of fire alarm systems is a three-step process at LANL. First the installing subcontractor or local installing craft performs quality control inspections and testing, and any required corrections. A Statement of Compliance and/or a Preliminary Test Report (if required) is to be provided to LANL, along with revised drawings and the current FACU program.

Next a LANL-supported, pre-final test is performed to verify correct DACT signals reporting to the LANL supervising station at the Emergency Operations Center (EOC). Changes made after the pre-final test will require sufficient time to make changes to LANL supervising station account.

Finally, the LANL-supported final acceptance test is performed.

For modifications to existing systems, the first step is limited/abbreviated because the final acceptance test must immediately follow demolition of existing and/or tie-in of new/modified portions of the system.

6.0 FIRE ALARM SYSTEM TIMELINE

A. All fire alarm installation documents (shop drawings), whether developed in Title II or Title III, shall, as a minimum, start as 60 percent design review, regardless of actual level of maturity, complexity, etc. A 30-percent design review is required for complex projects or those lacking a comprehensive preliminary/engineering design (Requirement 2-0249).

B. The table below describes the timeline for shop drawing review, programming coordination, pre- and final testing, and close-out for fire alarm system installations. Each deliverable shall be provided in a PDF file format, except where otherwise noted (Requirement 2-0250).

Deliverable	LMS 28 4600 r4 Spec Ref.[2]	Installation Documents Maturity/Review			Before Pre-Final Test[4]	Before Final Test[4]	After Final Acceptance Test
		[1]60%	[2]90%	[3]100%			
Certifications	1.5.A	X					
Design drawings including: Calculations Floor plans Wiring diagrams System input/output matrix	1.5.B	X	X	X	X		
Catalog data	1.5.B.1	X					
Installation instructions	1.5.B.8			X			
Materials and parts list	1.5.B.7.k	X	X	X			
Points/address list with description	1.5.B.9		X	X	X		X
FACU program and central station reports	1.5.B.10			X	X		X
Operations & Maintenance Manual	1.5.B.11						X
Test reports: • Installer's preliminary test report *(when requested)* • Test Plan • Final Acceptance Test Report • Record of Completion	1.5.C				X X		 X X
Revised: • FACU program • Central station reports • Input/output matrix • Drawings (red-lined)	3.15.D					X	
Project Record Documents[5] (as-built of all items)	1.5.D						X
Warranties	1.5.E						X

Table Notes

1. Shall be two full-size drawings unless 11 x 17 inches is determined to be acceptable during planning or preliminary design.
2. Typically 11 x 17-inch drawings are sufficient, unless full size is required by LANL Fire Protection Office reviewers.
3. 11 x 17-inch drawings are acceptable.
4. Sufficient time must be provided for coordination with the availability of the assigned FP Office Fire Alarm specialist and other LANL resources shared between projects (e.g., MSS electricians). Ten working days shall be required unless the FP Office agrees to fewer. Larger, complex projects or changes may require additional review time.
5. One full-sized and three 11 x 17-inch hardcopy drawing sets shall be delivered to the subcontractor technical representative (STR) unless FP Office allows electronic. Native AutoCAD or approved equivalent drawing files shall be delivered through the STR to Engineering Services, Institutional Project Delivery.

[2] Spec section numbering subject to change.