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CONDUCT OF MAINTENANCE (P950)
OPERATIONS AND MAINTENANCE MANUAL
OPERATIONS & MAINTENANCE CRITERION

TITLE: PREACTION SPRINKLER SYSTEMS

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DUSA CLASSIFICATION STATEMENT

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RECORD OF REVISIONS

Revision No.	Date	Description
0	08/27/98	Initial Issue
1	06/19/02 9/12/02	This revision reflects the conversion from a WordPerfect document into a Microsoft Word document and additional clarification on how to develop criteria. This revision includes: • The addition of a Table of Contents, • The use of basis statements in Sections 6, 7, and 9. • Revision to Section 9, "Required Documents," and • Further clarification in the use of references. • Changes per Writer's Guide changes and subcommittee requests for clarification.
2	8/04/03	Revision of Sections 6.1, 6.2 and 6.3 to clarify NFPA 25 requirements. Change all reference of DOE O 4330.4B to DOE O 433.1
3	7/27/10	Complete revision, including the following: • Changes reflect current LANL organizations • Change reference to reflect P950, *Conduct of Maintenance* • Remove DOE O 430.1B references from Section 1 • Incorporate 2008 edition of NFPA 25, *Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems* • Incorporate 2010 edition of NFPA 72, *National Fire Alarm and Signaling Code* • Incorporate LASO action on cancellation and modification of 1999-era equivalencies to portions of NFPA 25 and 72 (LASO Memorandum No. SO:21WF-203741, *National Fire Protection Association 25 and National Fire Protection Association 72 Equivalency Cancellation/Modification*, January 19, 2010)

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CRITERION 724

PREACTION SPRINKLER SYSTEMS

1.0 PURPOSE

The purpose of this Criterion is to establish the minimum requirements and best practices for operation and maintenance of preaction sprinkler systems at LANL.

This document addresses the requirements of P 315, *Conduct of Operations Manual,* and P 950, *Conduct of Maintenance*, by defining the minimum operations and maintenance criteria for structures, systems, and components (SSCs) that it covers. The Criterion lists requirements that are based on codes, standards, contract commitments, lessons learned, and LASO direction on previous equivalencies to some NFPA 25 and 72 inspection, testing and maintenance (ITM) requirements. It also lists recommendations based on industry practices, operational experience, or business case – where appropriate. Guidance for implementation of the requirements and recommendations is also provided.

Implementation of this Criterion satisfies the inspection, testing and maintenance (ITM) requirements of LANL PD 1220, Fire Protection Program, 10 CFR 851, Worker Safety and Health Program, Appendix A.2 "Fire Protection", and DOE Order 420.1B, Facility Safety, Chapter II "Fire Protection". Compliance with the NFPA codes herein are required per 10 CFR 851, Appendix A.2, and DOE O 420.1B Chapter II "Fire Protection," both of which are required per the LANL Prime Contract (DOE Contract No. DE-AC52-06NA25396) as part of implementing a comprehensive fire protection program.

2.0 SCOPE

The scope of this Criterion includes the routine inspection, testing and preventive and predictive maintenance of preaction sprinkler systems. This Criterion does not address corrective maintenance actions required to repair or replace equipment.

3.0 ACRONYMS AND DEFINITIONS

3.1 Acronyms

AHJ	Authority Having Jurisdiction
CFR	Code of Federal Regulations
DACS	Digital Alarm Communications System
DL	Division Leader
DOE	Department of Energy
DSA	Documented Safety Analysis
EOC	Emergency Operations Center
FACP	Fire Alarm Control Panel
FDC	Fire Department Connection
FOD	Facility Operations Director

FP-DO	LANL Fire Protection Division Office
ITM	Inspection, Testing, and Maintenance
LANL	Los Alamos National Laboratory
LASO	Los Alamos Site Office
ML	Management Level
MM	Maintenance Manager
NFPA	National Fire Protection Association
MSS	Maintenance and Site Services
NMED	New Mexico Environmental Department
NNSA	National Nuclear Security Administration
NOI	Notice of Intent
OM	Operations Manager
O&M	Operations and Maintenance
PPE	Personal Protective Equipment
SC	Safety Class
SS	Safety Significant
SSC	Systems, Structures, and Components
TSR	Technical Safety Requirement

3.2 Definitions

Management Level (ML1, ML2, ML3, ML4)- ML designation is used to grade the structures, systems, equipment, and components and associated activities based on their importance to the protection of the public, environment, and workers, security, and the Laboratory mission. See AP-341-502, *Management Level Determination* for definitions of each ML level.

Preaction Sprinkler System- A sprinkler system that is filled with water only from the underground fire main up to the preaction valve; the piping supplying the sprinklers on the system side of the preaction valve is normally dry. A preaction sprinkler system requires activation of the protected area fire detection system to actuate/open the preaction valve and allow water to be released into the preaction system piping. Closed sprinkler heads still must open in response to a fire to allow water to be discharged from the preaction system. In effect,there are two actions required before water is discharged from a preaction sprinkler system: (1) a fire alarm system has to detect a fire and open the preaction valve, and (2) sprinklers will have to actuate/open in response to heat from a fire. The preaction system piping will typically contain compressed air or nitrogen (N2) under relatively low pressure solely for supervisory (piping integrity monitoring) purposes. The system compressed air or N2 pressure is supervised by the fire alarm system and the LANL proprietary fire alarm monitoring station (DACS).

There are generally two types of preaction sprinkler systems:

(a) A single interlock preaction system, which admits water to the sprinkler system piping upon activation of the fire detection devices, and

(b) A double interlock preaction system, which requires both the activation of fire detection devices and actuation/opening of automatic sprinklers for the preaction valve to actuate and admit water into the sprinkler piping.

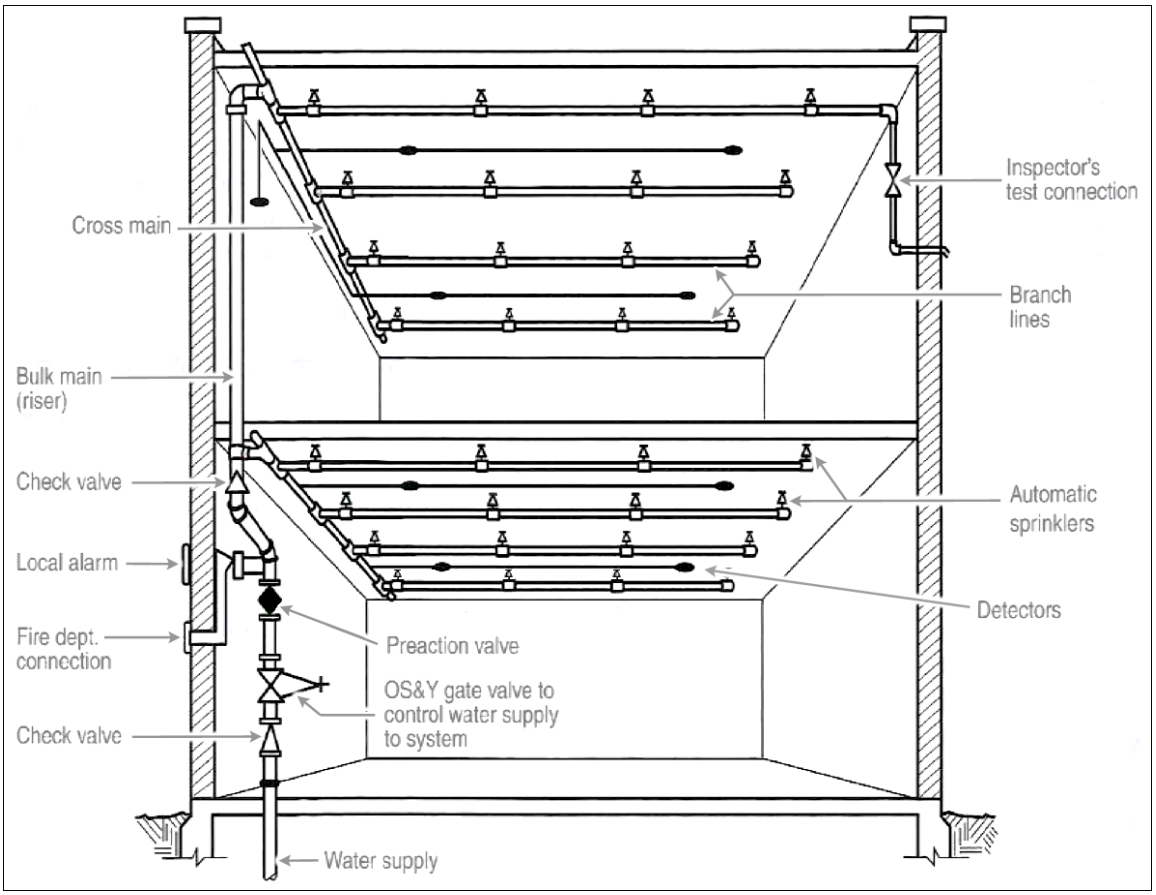

Figure 1: Typical Preaction Sprinkler System

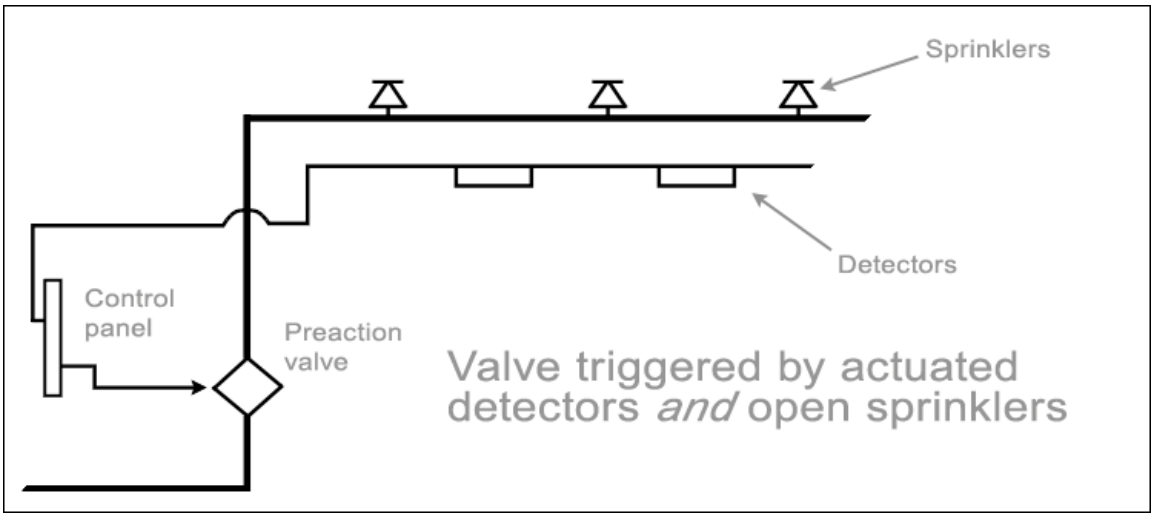

Figure 2: Double Interlock Preaction System

4.0 RESPONSIBILITIES

4.1 MSS-Division Leader (MSS-DL)

The Maintenance and Site Services (MSS) Division Leader (DL) receives and approves or rejects, in conjunction with the Authority Having Jurisdiction (AHJ), requests for variances from this Criterion. Maintains the record of decision for all variance requests.

4.2 MSS- Maintenance Programs (MSS-MP)

Responsible for the administrative content, and for monitoring applicability and implementation status of this Criterion. MSS-MP will assist organizations that are not applying or meeting the implementation expectations contained herein or will elevate their concerns to the appropriate level of LANL management.

4.3 Fire Protection Division Office (FP-DO)

The Fire Protection Division is responsible for the technical content of this Criterion and assessing the proper implementation across the Laboratory.

FP-DO shall provide technical assistance to support implementation of this Criterion and will assist organizations that are not applying or meeting the implementation expectations of this Criterion or will elevate their concerns to the appropriate level of LANL management.

4.4 Facility Operations Director (FOD)

Responsible for implementation of this O&M Criterion for identified systems/equipment within their facility boundaries.

4.5 Operations Manager (OM)

Responsible to the FOD for implementing operation portions of this Criterion and for coordinating transfer of systems/equipment to the Maintenance Manager for maintenance activities. The OM with concurrence of the FOD will prioritize implementation within budget allocations.

4.6 Maintenance Manager (MM)

Responsible to the FOD and the MSS-Division Leader for implementing the maintenance portions of this Criterion and for coordinating the transfer of systems/equipment to the Operations Manager at the conclusion of maintenance activities. The MM with concurrence of the FOD will prioritize implementation within budget allocations.

4.7 Authority Having Jurisdiction (AHJ)

The AHJ is the LANL Fire Marshal, who is responsible for providing a decision on specific technical questions regarding the systems or equipment relevant to this Criterion.

The LANL Fire Marshal in conjunction with the MSS Division Leader is the approval authority for all exceptions and variances to this Criterion. The LANL Fire Marshal cannot approve deviations or exemptions to the Code of Federal Regulations (CFR), Department of Energy (DOE) Orders or National Fire Protection Association (NFPA) Codes and Standards. The fire protection AHJ for these matters is the Los Alamos Site Office (LASO) Manager per DOE O 420.1B (see PD 1220).

5.0 PRECAUTIONS AND LIMITATIONS

5.1 Precautions

This section is not intended to identify all applicable precautions necessary for implementation of this Criterion. However, all applicable precautions should be contained in the implementing procedure(s) or work control authorization documents. The following precautions are intended only to assist the author of a procedure or work control document in the identification of hazards and precautions that may not be immediately obvious.

The discharge of large quantities of water (>5,000 gal) from a fire protection system may require the issuance of a Notice of Intent (NOI) to discharge this and greater quantities of water up to 3 weeks prior to the evolution to meet LANL commitments with the New Mexico Environment Department (NMED). NOIs must be coordinated with the LANL Environmental Protection Division.

Measures outlined in O & M Criterion 733, *Fire Protection Systems Impairment Control,* shall be initiated during inspection, testing, and maintenance activities that impair the operation of dry pipe sprinkler system.

Perform a main drain, or sectional drain, test each time after a valve has been closed and returned to service to verify that the valve is open.

5.2 Limitations

The intent of this Criterion is to identify the minimum requirements and recommendations for structures, systems, and components (SSCs) operation and maintenance across the Laboratory. Each Criterion user is responsible for the identification and implementation of additional facility specific requirements and recommendations based on their authorization basis and unique equipment and conditions, (e.g., equipment history, manufacturer warranties, operating environment, manufacturer O&M requirements and guidance, etc.)

Nuclear facilities and moderate to high hazard non-nuclear facilities will typically have additional facility-specific requirements beyond those presented in this Criterion. Nuclear facilities should implement the requirements of DOE Order 433.1B, *Maintenance Management Program for DOE Nuclear Facilities* as the minimum programmatic requirements for a maintenance program. Additional requirements and recommendations for SSC operation and maintenance may be necessary to fully comply with the current DOE Order or the Code of Federal Regulations (CFR) as applicable.

Nuclear facilities, certain high hazard facilities and explosives facilities may have additional facility specific requirements beyond those presented in this Criterion which are contained in the Documented Safety Analysis (DSA), Technical Safety Requirements (TSRs), or facility safety plans, as applicable.

6.0 REQUIREMENTS

Minimum requirements for all users are specified in this section. Requested variances to these requirements shall be prepared and submitted to MSS-MP and FP-DO for review and approval. The MSS Division Leader and LANL Fire Marshal approve or deny variances. The Criterion users are responsible for analysis of operational performance and SSC replacement or refurbishment based on this analysis. Laws, codes, contractual requirements, engineering

judgment, safety matters, and operations and maintenance experience drive the requirements contained in this section.

The requirements specified in this section are presented in a graded approach based on codes and standards (primarily NFPA 25, *Inspection, Testing, and Maintenance of Water-based Fire Protection Systems*), contract commitments, lessons learned, and LASO direction on previous equivalencies to some NFPA 25 and 72 ITM requirements.

In negotiation with LASO, FP-DO maintains the list of facilities designated as "high value" facilities for purposes of this Criterion.

Note: Discovery of SSC with a degraded or non-conforming condition is a triggering input to the Operability Determination and Functional Assessment process defined in AP-341-516, *Operability Determination and Functionality Assessment*. Degraded or non-conforming conditions include, but are not limited to, failed equipment or components, unsatisfactory readings, code or standard violations and fire protection impairments. Personnel performing tests or inspections under this O&M Criterion are not responsible nor authorized to perform the Operability Determination. Any degraded or non-conforming condition discovered under this O&M Criterion shall be communicated to the FOD Representative for input to the AP-341-516 process. While that process may not apply in Low Hazard Non-Nuclear and Office facilities, the same concept applies. The FOD organization is responsible to determine the response (taking equipment out of service, establishing fire watches, limiting operations, etc.) to SSC degraded and non-conforming conditions.

6.1 Operations Requirements

6.1.1 Baseline Operational Checklist

The preaction sprinkler system must remain operational at all times. The preaction sprinkler system shall be deemed operational when the following conditions are met:

1. All water supply control valves are in the fully open position,
2. All water supply control valves are properly supervised,
3. The water supply gauge pressure reads normal,
4. The air or N_2 supply gauge pressure is supervised and reads normal,
5. The fire alarm system that opens the preaction valve, monitors the initiation devices (detectors, manual pull stations, water flow alarms), and monitors supervision of the system control valves and air or N_2 pressure, is fully operational,
6. All areas protected by the preaction system are provided with smoke detectors, heat detectors, or flame/fire detectors as appropriate. Automatic detection is necessary in all areas protected by the preaction sprinkler system to detect a fire and activate the preaction valve,
7. Piping, fittings, hangers, bracing, sprinklers, valve trim, and other components are in their proper configuration and in good condition,

8. Sprinklers are unobstructed, i.e., (capable of developing proper discharge pattern and delivering sprinkler discharge to the hazard as per NFPA 13, *Standard for the Installation of Sprinkler Systems*, Section 8.5.5), including the following:
    a. continuous or non-continuous obstructions such as storage and partial-height partitions are at least 18 in below sprinkler deflectors;
    b. where fixed continuous or non-continuous obstructions beneath sprinklers are more than 48 in wide [ex., scaffold, platforms, ductwork, cable trays, cutting tables, experimental apparatus tables, laser tables, glove boxes, containment enclosures, screen rooms], sprinklers must be provided underneath and/or within;
    c. where intermediate sprinklers might be cooled by sprinklers located above, the intermediate level sprinklers are equipped with spray shields;
    d. sprinklers are a sufficient horizontal distance from ceiling-height obstructions (beams, walls, partitions, ducts, soffits, etc.) so that sprinkler spray pattern is not obstructed (refer to NFPA 13 for restrictions)
    e. pendent and upright sprinklers are at least 4 inches from wall
9. An adequate supply of water is available, with appropriate water pressure and quantity.

Basis: NFPA 25 (2008 edition), *Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems*; NFPA 13 (2010 edition), *Standard for the Installation of Sprinkler Systems*; and NFPA 72 (2010 edition), *National Fire Alarm Code*.

6.1.2 Nuclear Facilities, High-Hazard Non-nuclear Facilities and "High Value" Facilities

6.1.2.1 Daily Inspection(s)

Where preaction valves are subject to freezing and where the valve enclosure is not equipped with a remotely monitored low temperature alarm, valve enclosure heating equipment is to be inspected daily during cold weather for the ability to maintain a minimum valve enclosure temperature of 40° F.

6.1.2.2 Weekly Inspections

1. Where preaction valves are subject to freezing and where the valve enclosure is equipped with a remotely monitored low temperature alarm, valve enclosure heating equipment is to be inspected weekly during cold weather for the ability to maintain a minimum valve enclosure temperature of 40° F.
2. Inspect the supply side gauge of the preaction valve to verify normal water supply pressure is being maintained.
3. Where the air or N_2 pressure is not remotely-monitored, inspect the gauges on preaction systems to make sure normal supervisory air or N_2 pressures are being maintained.
4. Where provided, inspect reduced pressure backflow prevention assemblies to ensure the differential-sensing valve relief port is not continuously discharging.

Basis: NFPA 25 (2008 edition), *Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems*; NFPA 13 (2010 edition), *Standard for the Installation of Sprinkler Systems*; and NFPA 72 (2010 edition), *National Fire Alarm Code*. See also LASO Memorandum No. SO:21WF-203741, *National Fire Protection Association 25 and National Fire Protection Association 72 Equivalency Cancellation/Modification*, January 19, 2010.

*6.1.2.3 **Monthly Inspections***

1. The preaction valve, including pneumatic components, is externally inspected to verify:
    a. The valve is free from physical damage,
    b. All trim valves are in the appropriate open or closed position,
    c. The valve seat is not leaking, and
    d. Electrical components are in service.
2. The gauge monitoring the preaction system supervisory air or N_2 pressure where the air or N_2 pressure is remotely-monitored is inspected to verify it indicates normal pressure is being maintained.
3. The gauge monitoring the detection system pressure (such a pilot sprinkler or pneumatic rate of rise heat detector), if provided, is inspected to verify that normal air or N_2 pressure is being maintained.
4. Control valves, including preaction valve alarm line trim control valves (controlling water to a pressure switch and/or water motor gong) that are locked and/or electrically supervised by the facility fire alarm control panel (FACP) are inspected to ensure they are in the proper position (valve alignment) and properly locked and/or supervised.

Basis: NFPA 25 (2008 edition), *Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems*; NFPA 13 (2010 edition), *Standard for the Installation of Sprinkler Systems*; and NFPA 72 (2010 edition), *National Fire Alarm Code*.

*6.1.2.4 **Quarterly Inspections***

1. Inspect alarm devices (pressure and flow switches, valve supervision switches, etc.) to ensure they are free of physical damage.
2. Where applicable, inspect the hydraulic nameplate/placard to verify that it is securely attached to the sprinkler riser (or other approved location) and is legible.
3. Where provided, inspect pressure reducing valves to verify the valves are in the open position, not leaking, in good condition (hand wheels installed and not broken), and that downstream pressures are being maintained as designed.
4. Inspect the fire department connection (FDC) to verify:
    a. The FDC is visible and accessible,
    b. Couplings and swivels are not damaged and rotate smoothly,

c. Plugs or caps are in-place and in good condition,

d. Identification signs are in-place,

e. The check valve is not leaking,

f. The automatic drain valve is in-place and operating properly, and

g. The FDC internal clapper(s) is in-place and operating properly.

5. If FDC plugs or caps are not in place, inspect the interior of the connection for obstructions, and verify that the FDC clapper(s) is functional over its full range.

6. Where sprinkler heads are protected against overspray residue (e.g., paint spray booths, resin application rooms, mixing rooms) by cellophane or paper bags, inspect these bags to verify the lack of accumulation of heavy residue deposits.

Basis: NFPA 25 (2008 edition), *Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems*; NFPA 13 (2010 edition), *Standard for the Installation of Sprinkler Systems*; and NFPA 72 (2010 edition), *National Fire Alarm Code*.

6.1.2.5 Annual Inspections

1. Prior to the onset of freezing weather conditions in the Fall, buildings are inspected to verify that windows, skylights, doors, ventilators, and other openings and closures, blind spaces, unused attics, stair towers, roof penthouses, and low (crawl) spaces under buildings do not expose water-filled piping to freezing and verify that adequate heat [minimum 40°F] is available. Verify the functionality of heat tape and other freeze prevention systems where installed.

2. Inspect low temperature alarms, if installed in valve enclosures, at the beginning of the heating season.

3. For types of valves where the face plate has to be removed to reset the valve, inspect the interior of the valve and the condition of the detection devices when the system is trip-tested.

4. From floor level, verify that sprinkler piping and fittings are in good condition and free of mechanical damage, leakage, corrosion, or subject to external loads by materials either resting on the pipe or supported by the pipe or pipe supports (e.g., cabling strapped to piping).

   Note: Pipe and fittings installed within concealed spaces not visible from floor level need not be inspected. Pipe and fittings installed within areas that are inaccessible for safety considerations due to process operations are inspected during each scheduled shutdown or outage.

5. From floor level, verify that sprinkler pipe hangers and seismic bracing are in good condition and free of mechanical damage, leakage, corrosion, or subject to external loads by materials either resting on the pipe or supported by the pipe or pipe supports (e.g., cabling strapped to hangers or bracing).

Note: Hangers and seismic bracing installed within concealed spaces not visible from floor level need not be inspected. Hangers and seismic bracing installed within areas that are inaccessible for safety considerations due to process operations are inspected during each scheduled shutdown or outage.

6. From floor level, verify that sprinkler heads are in good condition and free of mechanical damage, foreign material (e.g., loading of lint, dust, oil residue and similar debris), paint (overspray), leakage, corrosion, and installed in the proper orientation (e.g., upright, pendant or sidewall). Glass bulb sprinklers are inspected to verify that the colored liquid is present.

   Note: Sprinkler heads installed within concealed spaces not visible from floor level need not be inspected. Sprinkler heads installed within areas that are inaccessible for safety considerations due to process operations are inspected during each scheduled shutdown or outage.

7. Verify that the proper number and type of spare sprinklers heads are available, and that a sprinkler head wrench is available for each type of head. The stock of spare sprinkler heads must include all types and ratings installed within the protected facility as follows -

   a. For facilities having no more than 300 sprinkler heads, no fewer than 6 sprinklers.

   b. For facilities having 300 to 1,000 sprinkler heads, no fewer than 12 sprinklers.

   c. For facilities having over 1,000 sprinkler heads, no fewer than 24 sprinklers.

Basis: NFPA 25 (2008 edition), *Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems*; NFPA 13 (2010 edition), *Standard for the Installation of Sprinkler Systems*; and NFPA 72 (2010 edition), *National Fire Alarm Code*.

6.1.3 Facilities that are not Nuclear Facilities, High-Hazard Non-nuclear Facilities or "High Value" Facilities

6.1.3.1 Weekly Inspections

Where provided, inspect reduced pressure backflow prevention assemblies to ensure the differential-sensing valve relief port does not discharge continuously.

6.1.3.2 Monthly Inspections

1. Inspect the gauge on the supply side of the preaction valve to verify the normal water supply pressure is being maintained.
2. Inspect the gauges on preaction systems to ensure normal supervisory air or N_2 pressures are being maintained.
3. Inspect the gauge monitoring the detection system pressure (such a pilot sprinkler or pneumatic rate of rise heat detector), if provided, to verify that normal air or N_2 pressure is being maintained.

Basis: NFPA 25 (2008 edition), *Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems*; NFPA 13 (2010 edition), *Standard for the Installation of Sprinkler Systems*; and NFPA 72 (2010 edition), *National Fire Alarm Code*.

6.1.3.3 Semi-Annual Inspections

1. Preaction valve enclosure heating equipment for preaction valves subject to freezing are inspected during cold weather for its ability to maintain a minimum valve room enclosure temperature of 40° F.
2. Externally inspect the preaction valve, including pneumatic components, to verify:
    a. The valve is free from physical damage,
    b. All trim valves are in the appropriate open or closed position,
    c. The valve seat is not leaking, and
    d. Electrical components are in service.
3. Control valves, including preaction valve alarm line trim control valves (controlling water to a pressure switch and/or water motor gong) that are locked and/or electrically supervised by the facility fire alarm control panel (FACP) are inspected to ensure they are in the proper position (valve alignment) and properly locked and/or supervised.
4. Alarm devices (pressure and flow switches, valve supervision switches, etc.) are inspected to ensure they are free of physical damage.
5. Where applicable, the hydraulic nameplate/placard is inspected to verify that it is securely attached to the sprinkler riser (or other approved location) and is legible.
6. Where provided, pressure reducing valves are inspected to verify the valves are in the open position, not leaking, in good condition (hand wheels installed and not broken), and that downstream pressures are being maintained as designed.
7. Fire department connection (FDC) is inspected to verify:
    a. The FDC is visible and accessible,
    b. Couplings and swivels are not damaged and rotate smoothly,
    c. Plugs or caps are in-place and in good condition,
    d. Identification signs are in-place,
    e. The check valve is not leaking,
    f. The automatic drain valve is in-place and operating properly, and
    g. The FDC internal clapper(s) is in-place and operating properly.
8. If FDC plugs or caps are not in-place, the interior of the connection shall be inspected for obstructions, and it shall be verified that the FDC clapper(s) is functional over its full range.

9. Where sprinkler heads are protected against overspray residue (e.g., paint spray booths, resin application rooms, mixing rooms) by cellophane bags having a thickness of 0.003 inches or less or thin paper bags, these bags are inspected to verify the lack of accumulation of heavy residue deposits and replaced as necessary. Sprinklers that have been painted shall be replaced. Cleaning and reusing painted sprinklers is not permitted.

Basis: NFPA 25 (2008 edition), *Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems*; NFPA 13 (2010 edition), *Standard for the Installation of Sprinkler Systems*; and NFPA 72 (2010 edition), *National Fire Alarm Code*.

6.1.3.4 Annual Inspections

1. Prior to the onset of freezing weather conditions in the Fall, buildings are inspected to verify that windows, skylights, doors, ventilators, and other openings and closures, blind spaces, unused attics, stair towers, roof penthouses, and low (crawl) spaces under buildings do not expose water-filled piping to freezing and verify that adequate heat [minimum 40°F] is available. Operability of heat tape and other freeze prevention systems is also verified where installed.
2. Low temperature alarms, if installed in valve enclosures, shall be inspected annually at the beginning of the heating season.
3. For types of valves where the face plate has to be removed to reset the valve, inspect the interior of the preaction valves and the condition of the detection devices when the system is trip-tested.
4. From floor level, sprinkler piping and fittings are inspected to verify that these are in good condition and free of mechanical damage, leakage, corrosion, or subject to external loads by materials either resting on the pipe or supported by the pipe or pipe supports (e.g., cabling strapped to piping).

   Note: Pipe and fittings installed within concealed spaces not visible from floor level need not be inspected. Pipe and fittings installed within areas that are inaccessible for safety considerations due to process operations are inspected during each scheduled shutdown or outage.
5. From floor level, sprinkler pipe hangers and seismic bracing are inspected to verify that these are in good condition and free of mechanical damage, leakage, corrosion, or subject to external loads by materials either resting on the pipe or supported by the pipe or pipe supports (e.g., cabling strapped to hangers or bracing).

   Note: Hangers and seismic bracing installed within concealed spaces not visible from floor level need not be inspected. Hangers and seismic bracing installed within areas that are inaccessible for safety considerations due to process operations are inspected during each scheduled shutdown or outage.
6. From floor level, sprinkler heads are inspected to verify that these are in good condition and free of mechanical damage, foreign material (e.g., loading of lint, dust, oil residue and similar debris), paint overspray, leakage, corrosion, and installed in the proper orientation (e.g., upright, pendant or sidewall). Glass bulb sprinklers are inspected to verify that the colored liquid is present.

7. **Note:** Sprinklers heads installed within concealed spaces not visible from floor level need not be inspected. Sprinkler heads installed within areas that are inaccessible for safety considerations due to process operations are inspected during each scheduled shutdown or outage.
8. The supply of spare sprinkler heads is inspected to verify that the proper number and type of sprinkler heads is available, and a sprinkler head wrench is available for each type of sprinkler head. The stock of spare sprinkler heads must include all types and ratings installed within the protected facility as follows -
    a. For facilities having no more than 300 sprinkler heads, no fewer than 6 sprinklers.
    b. For facilities having 300 to 1,000 sprinkler heads, no fewer than 12 sprinklers.
    c. For facilities having over 1,000 sprinkler heads, no fewer than 24 sprinklers.

Basis: NFPA 25 (2008 edition), *Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems*; NFPA 13 (2010 edition), *Standard for the Installation of Sprinkler Systems*; and NFPA 72 (2010 edition), *National Fire Alarm Code*.

6.2 Maintenance Requirements

The following are maintenance requirements for all automatic preaction sprinkler systems protecting LANL facilities; no distinction is made for facility hazard categorization or "high value." Ensure all system components are working. Repair or replace any components that fail a test or inspection in accordance with the manufacturer's instructions.

Note: Maintenance requirements for reduced pressure backflow prevention devices are outside the scope of this Criterion. See Criterion 406 for maintenance requirements for reduced pressure backflow prevention devices.

6.2.1 Annual Maintenance

1. Lubricate the operating stems of sprinkler system outside screw and yoke (OS&Y) valves. Then fully close and reopen the valve completely to test its operation and to distribute the lubricant. Graphite lubricant is recommended.

Note: Do not apply grease or other sealing materials to the seating surfaces of valves.

2. During the annual trip test, thoroughly clean the interior of the preaction valve, and replace or repair any parts as necessary. Interior cleaning and parts replacement or repair shall be permitted every 5 years for valves that can be reset without removal of a faceplate
3. Drain the low points in preaction systems after each operation and before the onset of freezing weather conditions.
4. Replace cellophane or paper bags used to protect sprinkler heads from overspray residue. Only cellophane bags having a thickness no greater than 0.003 in (0.076 mm) or thin paper bags may be used for this application.

    Note: While NFPA 13 is specific about the thickness of cellophane bags used for this purpose, it is non-specific on what constitutes a "thin" paper bag. It is

acceptable to use a typical lunch sack paper bag for this purpose. Relatively thick plastic bags have the potential to melt and adhere to the sprinkler head prior to sprinkler head activation, which could adversely affect the performance of the protected sprinkler head.

5. Complete a partial flow test of sprinkler system pressure reducing valves sufficient to move the valve from its seat.

6.2.2 5-Year Maintenance

1. Replace Gauges are replaced or tested by comparison with a calibrated gauge. Gauges not accurate to within 3% of the full scale are replaced or recalibrated.
2. Preaction system check valves and associated strainers, filters and restriction orifices are internally inspected and cleaned/repaired in accordance with manufacturer's instructions.
3. Internally inspect and clean/repair check valves in accordance with manufacturer's instructions.
4. Complete an inspection of piping and branch line conditions by opening a flushing connection at the end of one main and by removing a sprinkler head toward the end of one branch line to inspect for the presence of foreign organic and inorganic material.
5. Test or replace solder-type sprinkler heads with a temperature classification of extra high 325°F or greater that have been exposed to semi-continuous to continuous maximum allowable ambient temperature conditions. See Appendix A.
6. Test or replace sprinkler heads subject to harsh environments, including corrosive atmospheres and corrosive water supplies. See Appendix A.
7. Complete a full-flow test of sprinkler system pressure reducing valves and compare the results to previous test results and original design requirements. Make adjustments to the pressure reducing valves in accordance with manufacturer's instructions.

6.2.3 10-year Maintenance

Teat or replace dry type sprinkler heads (upright, pendant and sidewall). See Appendix A.

6.2.4 20-year Maintenance

Test or replace quick- and/or fast-response type sprinkler heads. See Appendix A.

6.2.5 50-year Maintenance

Test or replace standard response type sprinkler heads. See Appendix A.

6.3 Testing

6.3.1 Nuclear Facilities, High-Hazard Non-nuclear Facilities and "High Value" Facilities

The following are testing requirements for preaction sprinkler systems protecting LANL nuclear facilities (be they SC, SS or defense in-depth), high-hazard non-nuclear facilities, and other "high value" facilities.

Basis: NFPA 13 (2010 edition), NFPA 25 (2008 edition), and LASO Memorandum No. SO:21WF-203741, *National Fire Protection Association 25 and National Fire Protection Association 72 Equivalency Cancellation/Modification*, January 19, 2010.

6.3.1.1 Quarterly Testing

1. Test mechanical waterflow devices, including water motor gongs. Test flow through the inspector's test connection.
2. Test the priming water level in supervised preaction systems in accordance with manufacturer's instructions.
3. Where the sole water supply is through a back flow preventer and/or pressure reducing valves, conduct a main sprinkler system drain test.

Note: When there is a 10% reduction in the full flow residual pressure observed when compared to the original acceptance test or previous tests, the cause for the reduction will be identified and corrected.

6.3.1.2 Semi-Annual Testing

1. Test vane-type and pressure switch-type waterflow devices by flow through the inspector's test connection.
2. Test valve supervisory switches by operating the monitored valve. A supervisory alarm signal must be generated and transmitted to the alarm monitoring station either during the first two revolutions of a hand wheel or when the stem of the valve has moved one-fifth of the distance from its normal position.

6.3.1.3 Annual Testing

1. During warm weather, trip-test preaction valves in accordance with the manufacturer's instructions. In protected properties where water cannot be discharged into the system piping for test purposes, conduct the trip test so that it will not require discharge into the piping.
2. Test automatic fire detection devices and verify proper operation of the preaction valve.
3. Test all manual actuation devices.
4. Test automatic supervisory air or N_2 pressure maintenance devices in accordance with manufacturer's instructions.
5. If installed, test preaction valve room enclosure low temperature alarms.
6. Perform main drain test by fully opening and closing the main drain valve.

Note: When there is a 10% reduction in the full flow residual pressure observed when compared to the original acceptance test or previous tests, the cause for the reduction will be identified and corrected.

7. Fully close and reopen the system control valve(s).
8. Test backflow prevention assemblies as follows:
    a. A forward flow test is conducted at the designed flow rate of the sprinkler system (may include hose stream demands where fire hydrants and/or standpipe systems are located downstream of the backflow prevention assembly) to verify pressure loss through assembly is consistent with design assumptions.

b. A backflow performance test is conducted upon completion of the forward flow test.

Note: Where connections do not allow a full flow forward flow test, tests are conducted at the maximum flow rate possible.

6.3.1.4 5-year Testing

1. Test or replace solder-type sprinkler heads with a temperature classification of extra high 325°F or greater that have been exposed to semi-continuous to continuous maximum allowable ambient temperature conditions. See Appendix A.
2. Test sprinkler heads subject to harsh environments, including corrosive atmospheres and corrosive water supplies. See Appendix A.
3. Complete a full-flow test of sprinkler system pressure reducing valves and compare the results to previous test results and original design requirements. Make adjustments to the pressure reducing valves in accordance with manufacturer's instructions.

6.3.1.5 10-year Testing

Test dry type sprinkler heads (upright, pendant and sidewall). See Appendix A.

6.3.1.6 20-year Testing

Test quick- and/or fast-response type sprinkler heads. See Appendix A.

6.3.1.7 50-year Testing

Test or replace standard response type sprinkler heads. See Appendix A.

6.3.2 Facilities that are not Nuclear Facilities, High-Hazard Non-nuclear Facilities or "High Value" Facilities

The following are testing requirements for preaction sprinkler systems protecting LANL facilities that are not nuclear facility, high-hazard non-nuclear facility, and designated as "high value" facility.

6.3.2.1 Semi-Annual Testing

1. Test mechanical waterflow devices, including water motor gongs. Test by flow through the inspector's test connection.
2. Test vane-type and pressure switch-type waterflow devices by flow through the inspector's test connection.
3. Test valve supervisory switches by operating the monitored valve. A supervisory alarm signal must be generated and transmitted to the alarm monitoring station either during the first two revolutions of a hand wheel or when the stem of the valve has moved one-fifth of the distance from its normal position. Two separate and distinct supervisory alarm signals are required to be initiated: one indicating movement of the valve from its normal position (off normal), and the other indicating restoration of the valve to its normal position.

4. Test the priming water level in supervised preaction systems in accordance with manufacturer's instructions.
5. A main drain test is conducted on sprinkler systems which are supplied solely through a back flow preventer and/or pressure reducing valves.

Note: When there is a 10% reduction in the full flow residual pressure observed when compared to the original acceptance test or previous tests, the cause for the reduction will be identified and corrected

6.3.2.2 Annual Testing

1. During warm weather, trip-test preaction valves in accordance with the manufacturer's instructions. In protected properties where water cannot be discharged into the system piping for test purposes, conduct the trip test so that it will not require discharge into the piping.
2. Test automatic fire detection devices and verify proper operation of the preaction valve.
3. Test all manual actuation devices.
4. Test automatic supervisory air or N_2 pressure maintenance devices in accordance with manufacturer's instructions.
5. If installed, test preaction valve room enclosure low temperature alarms.
6. Perform main drain test by fully opening and closing the main drain valve.

Note: When there is a 10% reduction in the full flow residual pressure observed when compared to the original acceptance test or previous tests, the cause for the reduction will be identified and corrected.

7. Fully close and reopen the system control valve(s).
8. Test backflow prevention assemblies are tested as follows:
    a. A forward flow test is conducted at the designed flow rate of the sprinkler system (may include hose stream demands where fire hydrants and/or standpipe systems are located downstream of the backflow prevention assembly) to verify pressure loss through assembly is consistent with design assumptions.
    b. A backflow performance test is conducted upon completion of the forward flow test.

Note: Where connections do not allow a full flow forward flow test, tests are conducted at the maximum flow rate possible.

6.3.2.3 5-year Testing

1. Test or replace solder-type sprinkler heads with a temperature classification of extra high 325°F or greater that have been exposed to semi-continuous to continuous maximum allowable ambient temperature conditions. See Appendix A.
2. Test or replace sprinkler heads subject to harsh environments, including corrosive atmospheres and corrosive water supplies. See Appendix A.

3. Complete a full-flow test of sprinkler system pressure reducing valves and compare the results to previous test results and original design requirements. Adjustments made to the pressure reducing valves are made in accordance with manufacturer's instructions.

6.3.2.4 10-year Testing

Test dry type sprinkler heads (upright, pendant and sidewall) . See Appendix A.

6.3.2.5 20-year Testing

Test or replace quick- and/or fast-response type sprinkler heads. See Appendix A.

6.3.2.6 50-year Testing

Test or replace standard response type sprinkler heads. See Appendix A.

6.4 Other ITM Requirements

6.4.1 General

Ensure all system components are in proper working order. Repair or replace any components that fail a test or inspection in accordance with the manufacturer's instructions.

6.4.2 Sprinkler heads:

1. Replacement sprinkler heads shall have the appropriate characteristics for the application intended. These characteristics shall include proper:
    a. style,
    b. orifice size and K factor,
    c. temperature rating,
    d. coating (if any),
    e. deflector type (e.g., upright, pendant, sidewall), and
    f. design requirements.
    g. Use only new, listed sprinklers as replacements.
2. Protect sprinklers covering spray-coating areas against overspray residue. Only cellophane bags having a thickness no greater than 0.003 in (0.076 mm) or thin paper bags may be used for this application.

    Note: While NFPA 13 is specific about the thickness of cellophane bags used for this purpose, it is non-specific on what constitutes a "thin" paper bag. It is acceptable to use a typical lunch sack paper bag for this purpose. Relatively thick plastic bags have the potential to melt and adhere to the sprinkler head prior to sprinkler head activation, which could adversely affect the performance of the protected sprinkler head.
3. Conduct an obstruction investigation for sprinkler systems and yard main piping whenever any of the following conditions exist:
    a. If discharge of obstructive materials is found during routine water flow tests.

b. If foreign materials are discovered in fire pumps or check valves.

c. If foreign material is found in water during drain tests or plugging of inspector's test connection(s).

d. If plugged sprinkler heads are found.

e. If plugged piping is found in sprinkler systems dismantled during building alterations.

f. If yard piping or surrounding public mains are not flushed following new installations or repairs.

g. If a record of broken public mains in the vicinity exists.

h. If a system that is returned to service after an extended shutdown (> 1 year).

i. If there is reason to believe that the sprinkler system contains sodium silicate or highly corrosive fluxes in copper systems.

j. If a system has been supplied with raw water via the fire department connection.

k. If pinhole leaks are found.

Basis: NFPA 13 (2010 edition), and NFPA 25 (2008 edition).

6.5 Impairments and Modifications

If one or more of the Operational requirements listed in Section 6.1.1 are not maintained, follow the actions outlined in Criterion 733, Fire Protection System Impairment Control Program.

6.5.1 Post-Modification Testing

Whenever a component or the system is adjusted, repaired, reconditioned, replaced or modified, the actions listed in Appendix B, *Component and System Action Requirements*, are completed.

Basis: NFPA 25 (2008 edition). .

7.0 RECOMMENDED AND GOOD PRACTICES

The information provided in this section is recommended based on acceptable industry practices and should be implemented by each user based on the unique application and operating history of the subject systems/equipment.

7.1 Operations Recommendations

There are no operational recommendations for this Criterion.

7.2 Maintenance Recommendations

The supervisory air in preaction systems should be dried to minimize internal pipe corrosion.

8.0 GUIDANCE

8.1 Operations Guidance

There is no operational guidance for this Criterion.

8.2 Maintenance Guidance

There is no maintenance guidance for this Criterion.

9.0 REQUIRED DOCUMENTATION

Table 9-1: Maintenance History Documentation Parameters

Parameter	ML 1	ML 2	ML 3	ML 4
Maintenance Activities				
Repair / Adjustments	**Required**	**Required**	**Required**	**Required**
PM Activities	**Required**	**Required**	**Required**	**Required**
Equipment Problems				
Failure Dates	**Required**	**Required**	**Required**	**Required**
Failure Root Cause	**Required**	**Required**	**Required**	**Required**
Inspection Results				
Inspection Date	**Required**	**Required**	**Required**	**Required**
SSC Condition	**Required**	**Required**	**Required**	**Required**
'-' indicates documentation is not required.				

Basis: Documentation of the parameters listed in Table 9-1 above satisfies the requirements of P 950, Section 3.5.15 which states, "A maintenance history and trending program is maintained to document data, provide historical information for maintenance planning, and support maintenance and performance trending of facility systems and components"

10.0 REFERENCES

The following references, and associated revisions, were used in the development of this document.

10.1 10 CFR 851, Worker Safety and Health Program, Appendix A.2 "Fire Protection"

10.2 AP-341-502, Management Level Determination

10.3 AP-341-516, Operability Determination and Functionality Assessment

10.4 AP-MNT-010, *Maintenance History*

10.5 DOE Order 420.1B, *Facility Safety*, Chapter II "Fire Protection"

10.6 DOE Order 430.1B, *Real Property Asset Management*

10.7 DOE Order 433.1B, *Maintenance Management Program for DOE Nuclear Facilities*

10.8 LANL Equivalency to NFPA 25, which consists of:

(a) LANL Memorandum No. FE-21-98-005, *Proposed Equivalency to NFPA Standard 25*, dated June 9, 1998;

(b) DOE AOO/LAOO Memorandum No. LAAMFO:3TR-021, *Fire Protection Inspection, Test, and Maintenance Requirements*, dated June 9,1998; and

(c) DOE AOO Memorandum No. TASD:98-068:pc, *Disposition of LANL Equivalency Requests to NFPA 25 – Inspection, Testing, and Maintenance (ITM) Frequencies for Water-Based Fire Protection Systems*, dated July 24, 1998

10.9 LASO Memorandum No. SO:21WF-203741, National Fire Protection Association 25 and National Fire Protection Association 72 Equivalency Cancellation/Modification, January 19, 2010.

10.10 NFPA 13, 2010 Edition, *Standard for the Installation of Sprinkler Systems*

10.11 NFPA 25, 2008 Edition, *Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems*

10.12 NFPA 72, 2010 Edition, *National Fire Alarm and Signaling Code*

10.13 P 315, *Conduct of Operations Manual*

10.14 P 950, *Conduct of Maintenance*

10.15 PD 1220, *Fire Protection Program*

11.0 APPENDICES

Appendix A. *Sprinkler Testing Requirements*
Appendix B. *Component and System Action Requirements*

Appendix A
Sprinkler Testing Requirements

(*Basis:* NFPA 25 (2008 edition), *Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems*)

1. Where required below, sample sprinklers shall be submitted to a recognized testing laboratory acceptable to the AHJ for field service testing.

    a. Where sprinklers have been in service for 50 years, they shall be replaced or representative samples from one or more sample areas shall be tested. Test procedures shall be repeated at 10-year intervals.
    b. Sprinklers manufactured using fast-response elements that have been in service for 20 years shall be tested. They shall be tested at 10-year intervals.
    c. Representative samples of solder-type sprinklers with a temperature classification of extra high 163ºC (325ºF) or greater that are exposed to semi-continuous to continuous maximum allowable ambient temperature conditions shall be tested at 5-year intervals.
    d. Where sprinklers have been in service for 75 years, they shall be replaced or representative samples from one or more sample areas shall be submitted to a recognized testing laboratory acceptable to the AHJ for field service testing. Test procedures shall be repeated at 5-year intervals.
    e. Dry sprinklers that have been in service for 10 years shall be tested or replaced. If maintained and serviced, they shall be retested at 10-year intervals.
    f. Where sprinklers are subjected to harsh environments, including corrosive atmospheres and corrosive water supplies, on a 5-year basis, sprinklers shall either be replaced or representative sprinkler samples shall be tested.
    g. Where historical data indicates, longer intervals between testing shall be permitted.

2. A representative sample of sprinklers for testing per step 1 above shall consist of a minimum of not less than 4 sprinklers or 1% of the number of sprinklers per individual sprinkler sample, whichever is greater.

3. Where one sprinkler within a representative sample fails to meet the test requirement, all sprinklers represented by that sample shall be replaced.

Appendix B
Component and System Action Requirements

(*Basis:* NFPA 25, 2008 Edition, Table 5.5.1)

Component	Adjust/ Modify	Repair/ Recondition	Replace	Required ITM Action
Pipe and fittings affecting < 20 sprinklers	**X**	**X**	**X**	Check for leaks at system working pressure
Pipe and fittings affecting ≥ 20 sprinklers	**X**	**X**	**X**	Hydrostatic test per NFPA 13 (e.g., 200 psig for 2 hours)
Sprinklers < 20	**X**		**X**	Check for leaks at system working pressure
Sprinklers ≥ 20	**X**		**X**	Hydrostatic test per NFPA 13 (e.g., 200 psig for 2 hours)
FDC	**X**	**X**	**X**	Inspect per Section 6.1.2.3
Control Valves	**X**	**X**	**X**	Fully close and reopen the valve Lock in open position
Vane-type waterflow	**X**	**X**	**X**	Operational test using inspector's test connection
Pressure switch-type waterflow	**X**	**X**	**X**	Operational test using inspector's test connection
Water motor gong	**X**	**X**	**X**	Operational test using inspector's test connection
Valve supervision switch	**X**	**X**	**X**	Operational test per NFPA 13/72 (i.e., signal shall be produced during either of the first two revolutions of a hand wheel or when stem has moved one-fifth of the distance from normal position)
Gauges	**X**	**X**	**X**	Verify at 0 psi and at system working pressure
Main Drain	**X**	**X**	**X**	Perform main drain test per Section 6.3.2.2
Auxiliary Drain(s)	**X**	**X**	**X**	Check for leaks at system working pressure Perform main drain test per Section 6.3.2.2
Inspector's test connection	**X**	**X**	**X**	Check for leaks at system working pressure Perform main drain test per Section 6.3.2.2