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

TITLE: GASEOUS AGENT FIRE EXTINGUISHING SYSTEMS

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RECORD OF REVISIONS

Revision No.	Date	Description
0	11/13/03	Initial Issue
1	6/15/10	<p>Complete revision, including the following -</p> <ul style="list-style-type: none"> • Changes reflect current LANL organizations and responsibilities, corrections, clarifications and examples • Change reference to reflect P950, <i>Conduct of Maintenance</i> • Incorporate 2008 edition of NFPA 12, <i>Standard on Carbon Dioxide Fire Extinguishing Systems</i>. • Incorporate 2009 edition of NFPA 12A, <i>Standard on Halon 1301 Fire Extinguishing Systems</i>. • Incorporate 2008 edition of NFPA 2001, <i>Standard on Clean Agent Fire Extinguishing Systems</i> • Incorporate 2010 edition of NFPA 72, <i>National Fire Alarm and Signaling Code</i> • Incorporate LASO action on cancellation and modification of 1999-era equivalencies to portions of NFPA 25 and 72 (LASO Memorandum No. SO:21WF-203741, <i>National Fire Protection Association 25 and National Fire Protection Association 72 Equivalency Cancellation/Modification, January 19, 2010</i>)

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CRITERION 727

GASEOUS AGENT FIRE EXTINGUISHING SYSTEMS

1.0 PURPOSE

The purpose of this Operations & Maintenance (O&M) Criterion is to establish the minimum requirements and best practices for operation and maintenance of local application and total flooding gaseous agent fire extinguishing systems at Los Alamos National Laboratory (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 that it covers. The Criterion lists requirements that are based on codes, standards, contract commitments, lessons learned, or business case. It also lists recommendations based on industry practices, operational experience, or business case. Guidance for implementation of the requirements and recommendations is also provided.

2.0 SCOPE

The scope of this O&M Criterion includes the routine inspection, testing and preventive and predictive maintenance of local application and total flooding gaseous agent fire extinguishing systems. The gaseous agents include Halon 1301, which is being phased-out; Carbon Dioxide (CO₂); and other clean agents such as FM-200 and Inergen. This O&M Criterion addresses recommended preventative and corrective maintenance actions in Section 7.2.

Refer to O&M Criterion 731, *Portable Fire Extinguishers*, and NFPA 10, *Portable Fire Extinguishers*, for inspection, testing and maintenance requirements for portable fire extinguishers using clean agents.

3.0 ACRONYMS AND DEFINITIONS

3.1 Acronyms

AHJ	Authority Having Jurisdiction
CFR	Code of Federal Regulations
CO ₂	Carbon Dioxide
DOE	Department of Energy
DSA	Documented Safety Analysis
FOD	Facility Operations Director
ITM	Inspections, Testing and Maintenance
LANL	Los Alamos National Laboratory
LASO	Los Alamos Site Office

ML	Management Level
MM	Maintenance Manager
MSS	Maintenance and Site Services
MSS-DL	Maintenance and Site Services Division Leader
MSS-MP	Maintenance and Site Services Maintenance Programs
NFPA	National Fire Protection Association
O&M	Operations & Maintenance
OM	Operations Manager
PM	Preventative Maintenance
SSC	Structures, Systems and Components
TSR	Technical Safety Requirements

3.2 Definitions

Clean Agent- A gaseous fire extinguishing agent that is electrically nonconductive, environmentally acceptable to discharge, and leaves no residue upon evaporation. CO₂ and FM-200 are examples of these types of agents that are currently in use at LANL.

Halon- A halogenated hydrocarbon (halocarbon) gaseous fire extinguishing agent. Halons include Bromochlorodifluoromethane (Halon 1211), bromotrifluoromethane (Halon 1301), and mixtures of Halon 1211 and Halon 1301 (Halon 1211/1301). The only Halon this O&M Criterion addresses is Halon 1301.

Gaseous Agent- A gaseous fire extinguishing agent. The primary types of gaseous agents are CO₂, Halons and newer clean agents. This O&M Criterion addresses all these agents.

Hydrostatic Testing- Pressure testing of the gaseous agent storage container to verify its strength against unwanted rupture.

Local Application- The act and manner of discharging a fire extinguishing agent onto a protected fire hazard for a specified duration for the purposes of achieving fire extinguishment. There are presently no local application clean agent fire extinguishing systems in-service at LANL.

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.

Total Flooding- The act and manner of discharging a fire extinguishing agent into a protected space for the purpose of achieving a specified minimum agent concentration throughout the protected space for a specified duration (“hold-time”).



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 Facility Operations Director (FOD)

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

4.4 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.

4.5 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.

4.6 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.

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 for review and approval. The MSS Division Leader approves or denies 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.

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

Refer to O&M Criterion 720, *Fire Alarm Systems*, and to NFPA 72, *National Fire Alarm and Signaling Code*, for operations requirements related to the detection system that discharges the extinguishing agent. For clean agent fire extinguishing systems, initiating devices including smoke detectors, heat detectors and manual pull/releasing stations are tested accordance with Appendix B of O&M 720, including the frequencies established by NFPA 72. For clean agent fire extinguishing systems, the approved exception that allows a 2-year frequency for testing initiating devices including smoke detectors, heat detectors and manual pull/releasing stations is not applicable.

6.1.1 Baseline Operations Checklist

Gaseous agent fire extinguishing systems must be operable at all times. A system shall be deemed operable when the following conditions are met:

1. An adequate number of containers filled with fire extinguishing agent is available and in functioning condition as part of the extinguishing system.
2. Discharge nozzles are in-place, aligned properly, and unobstructed.
3. Ceiling tiles and other movable items near discharge nozzles are well-secured.
4. Activation devices are in-place and are in good repair.
5. All warning signs are present and clearly visible.
6. The fire detection system for the protected space is in-service (devices are functioning, device circuits are monitored by system control panel).
7. The system control/releasing panel is fully functional, monitoring and controlling all appropriate devices, with the ability to relay alarm, supervisory and trouble signals to the LANL proprietary fire alarm system.
8. All penetrations in the perimeter (walls, floor/ceiling) of the protected space are sealed, closed, or connected to an automatic closing system (electromagnetic doors, dampers, etc.) that is activated by operation of the extinguishing system.
9. All equipment interlocks are in operating condition (e.g., automatic closure of doors/dampers, automatic shutdown of ventilation systems, etc.)

10. Extinguishing agent container brackets are in good repair. The system piping, fittings, and hangers are in good repair.
11. An adequate reserve supply of extinguishing agent is available (if a connected reserve is not already provided) in containers that can be immediately connected to the extinguishing system.

6.2 Maintenance Requirements

Refer to O&M Criterion 720, *Fire Alarm Systems*, and to NFPA 72, *National Fire Alarm and Signaling Code*, for maintenance requirements related to the detection system that discharges the extinguishing agent. For clean agent fire extinguishing systems, initiating devices including smoke detectors, heat detectors and manual pull/releasing stations are tested accordance with Appendix B of O&M Criterion 720, including the frequencies established by NFPA 72. For clean agent fire extinguishing systems, the approved exception that allows a 2-year frequency for testing initiating devices including smoke detectors, heat detectors and manual pull/releasing stations is not applicable.

6.3 Testing Requirements

Refer to O&M Criterion 720, *Fire Alarm Systems*, and to NFPA 72, *National Fire Alarm and Signaling Code*, for testing requirements related to the detection system that discharges the extinguishing agent. For clean agent fire extinguishing systems, initiating devices including smoke detectors, heat detectors and manual pull/releasing stations are tested accordance with Appendix B of O&M Criterion 720, including the frequencies established by NFPA 72. For clean agent fire extinguishing systems, the approved exception that allows a 2-year frequency for testing initiating devices including smoke detectors, heat detectors and manual pull/releasing stations is not applicable.

6.3.1 Weekly

For low pressure liquid CO₂ containers check gauges and if at any time a container shows a loss of more than 10%, refill or replace container.

6.3.2 Semi-Annually

Inert Gas Clean Agent

Check the container pressure gauges for proper operating pressures. If the loss in pressure exceeds 5%, replace or refill the containers.

Carbon Dioxide

Weigh each high pressure CO₂ container. If a container shows a loss in net weight of more that 10%, replace or refill container.

Halon

1. Weigh each Halon container. If a container shows a loss in net weight of more than 5% or a loss in pressure of more than 10%, replace or refill the containers.

Record the weight and pressure on the attached tag, work instruction and/or work package.

2. Verify that containers are properly mounted and undamaged.
3. Visually inspect the physical condition of and test the entire fire extinguishing system, except that discharge testing is not required. See Section 6.3 for testing requirements.
4. Thoroughly inspect the enclosure (floor, walls and ceiling) making sure all ceiling tiles are secured properly. Check all openings (e.g., doors, dampers, etc.) enclosing the protected space to verify they are closed or connected to an automatic closure system. Check that all mechanical, electrical and miscellaneous penetrations are properly sealed.
5. Operate control activation devices (ensure that explosive squibs are inactive).
6. Conduct an operational test of the system. Test all auxiliary functions, such as damper and door release controls, without discharging the system.
7. Test time delays without discharging the system.

Basis: NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2008 edition, NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 2009 edition, and NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2008 edition. Compliance with these NFPA Codes 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 as part of implementing a comprehensive fire protection program.

6.3.3 Annually (Except Halon Systems)

1. Verify that containers are properly mounted and undamaged.
2. Visually inspect the physical condition of and test the entire fire extinguishing system, except that discharge testing is not required. See Section 6.3 for testing requirements.
3. Thoroughly inspect the enclosure (floor, walls and ceiling) making sure all ceiling tiles are secured properly. Check all openings (e.g., doors, dampers, etc.) enclosing the protected space to verify they are closed or connected to an automatic closure system. Check that all mechanical, electrical and miscellaneous penetrations are properly sealed.
4. Operate control activation devices (ensure that explosive squibs are inactive).
5. Conduct an operational test of the system. Test all auxiliary functions, such as damper and door release controls, without discharging the system.
6. Test time delays without discharging the system

Basis: NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2008 edition, NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 2009 edition, and NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2008 edition. Compliance with these NFPA Codes 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 as part of implementing a comprehensive fire protection program.

Note: Halon systems have a semi-annual testing requirement, but not an annual requirement.

6.3.4 Five (5) Years

1. Test all hoses in accordance with applicable NFPA standards and manufacturer recommendations.
2. Hydrostatic test need to be completed before refilling a discharged container if last hydrostatic test date is more than 5 years old.

Basis: NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2008 edition, NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 2009 edition, and NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2008 edition. Compliance with these NFPA Codes 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 as part of implementing a comprehensive fire protection program.

6.3.5 Twelve (12) Years

Perform a hydrostatic test on all agent storage cylinders.

Note: Conduct tests with trained and qualified personnel according to the procedures in the applicable NFPA Code and manufacturer's recommendations.

Basis: Frequency: NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2008 edition; GE Global Asset Protection Services Guideline GAP.13.4.1.1, *Halon 1301 Systems*; GE Global Asset Protection Services Guideline GAP.13.6.1, *Clean Agent Systems*; and GE Global Asset Protection Services Guideline GAP.13.3.1 *Carbon Dioxide Systems*. Compliance with this NFPA Code is 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 as part of implementing a comprehensive fire protection program.

Procedure: NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2008 edition, NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 2009 edition, and NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2008 edition. Compliance with these NFPA Codes 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 as part of implementing a comprehensive fire protection program.

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

Persons other than MSS Fire Protection Maintenance personnel may conduct the visual inspections identified in this document.

7.2 Maintenance Recommendations

Purchase an annual service contract with a company experienced in installing and servicing gaseous agent fire extinguishing systems. The service contract should include all of the annual Inspections, Testing and Maintenance (ITM) requirements as well as emergency response for replacing extinguishing agent containers within 24 hours after a system discharge.

Basis: The complexity of gaseous extinguishing systems warrants having servicing agencies experienced in installing them perform the ITM. In addition, the inability to operate with gaseous fire extinguishing systems out of service may warrant assurance of prompt replacement of agent after a system discharge.

7.3 Testing Recommendations

To minimize the duration of impairment, replace the agent containers that are out for hydrostatic testing. Send containers out for hydrostatic testing to a service company trained and equipped to perform this testing safely.

8.0 GUIDANCE

8.1 Operations Guidance

None.

8.2 Maintenance Guidance

None.

8.3 Testing Guidance

None.

9.0 REQUIRED DOCUMENTATION

Maintenance history shall be maintained for gaseous agent fire extinguishing systems to include, as a minimum, the parameters listed in the Table 9-1 below:



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
<i>'-' indicates documentation is not required.</i>				

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 DOE O 430.1B, *Real Property Asset Management*
- 10.5 DOE Order 420.1B, *Facility Safety*, Chapter II "Fire Protection"
- 10.6 DOE Order 433.1B, *Maintenance Management Program for DOE Nuclear Facilities*
- 10.7 GE GAPS.13.3.1, *Carbon Dioxide Systems*
- 10.8 GE GAPS.13.4.1.1, *Halon 1301 Systems*
- 10.9 GE GAPS.13.6.1, *Clean Agent Systems*
- 10.10 LASO Memorandum No. SO:21WF-203741, *National Fire Protection Association 25 and National Fire Protection Association 72 Equivalency Cancellation/Modification*, January 29, 2010



- 10.11 NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2008 edition
- 10.12 NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 2009 edition
- 10.13 NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2008 edition
- 10.14 NFPA 72, *National Fire Alarm and Signaling Code*®, 2010 edition
- 10.15 O&M Criterion 720, *Fire Alarm Systems*
- 10.16 O&M Criterion 733, *Fire Protection System Impairment Control Program*
- 10.17 P 315, *Conduct of Operations Manual*
- 10.18 P 950, *Conduct of Maintenance*
- 10.19 PD 1220, *Fire Protection Program*

11.0 APPENDICES

None.