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APPENDIX I

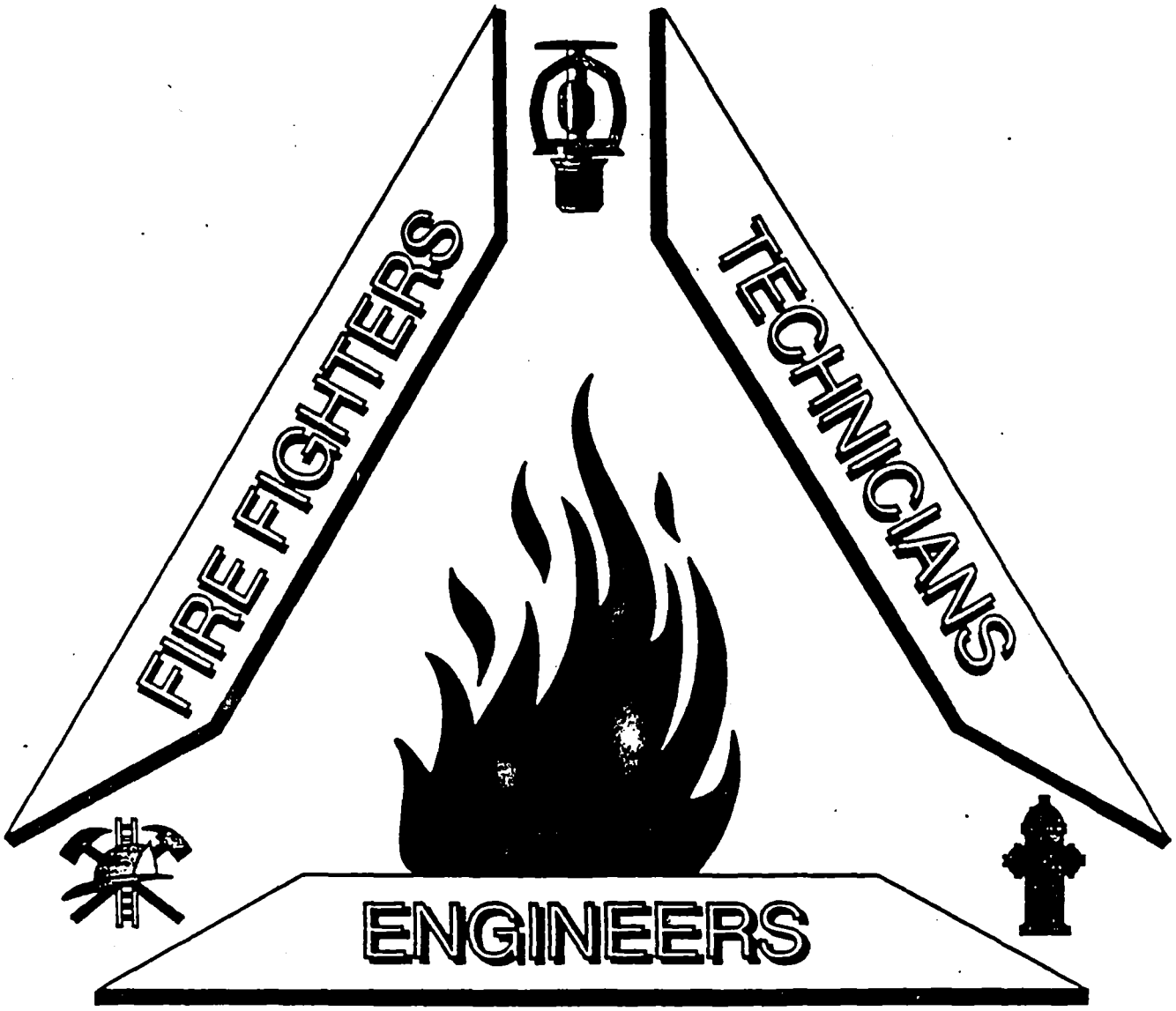
OAK RIDGE OPERATIONS OFFICE FIRE PREVENTION AND PROTECTION PROGRAMS

7TH EDITION - 1995

Prepared by:

Oak Ridge Operations Office & Contractors

FIRE PROTECTION



for the Department of Energy

CONTENTS

I. INTRODUCTION

These DOE/ORO Fire Prevention and Protection interpretive guides are a supplement to U. S. Department of Energy Orders. DOE fire protection programs were based upon principles long accepted within that portion of American industry known as "Highly Protected Risk." The concept is similar to the defense-in-depth principles used within the nuclear utility industry. These terms imply that ORO sites employ qualified fire protection engineering judgement and ensure compliance with regulatory and national consensus codes and standards, as a minimum, to obtain the highest economically justifiable level of industrial loss prevention and protection.

Fire is a major cause of property damage, production interruption, environmental insults, contamination, and a significant cause of accidental death within DOE and its predecessor agencies. With approximately 24,000 employees and a replacement value of $27 billion, ORO has sustained an exemplary fire protection record and program.

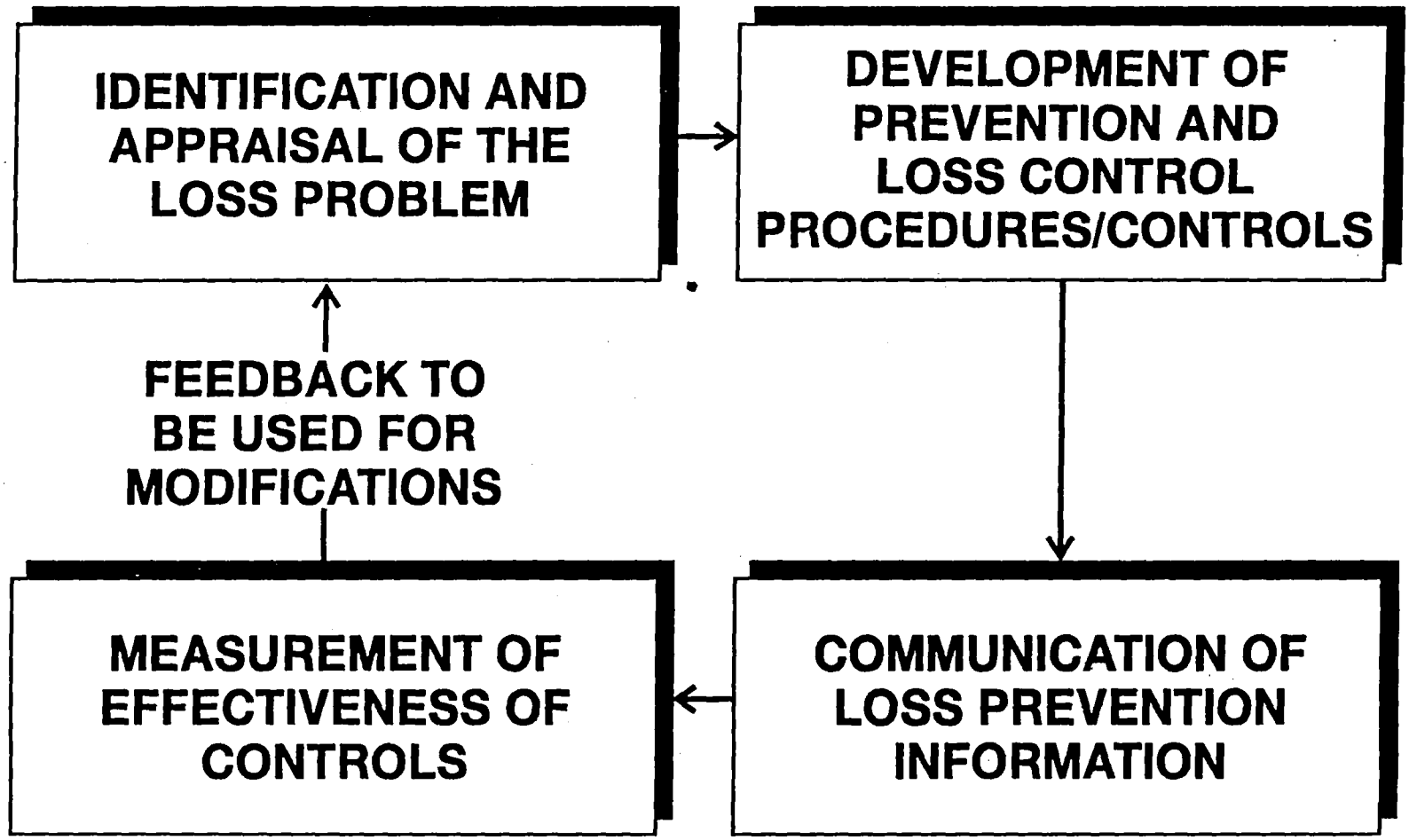
There are several reasons for the ORO record. Above all is a performance based program that requires a "Highly Protected Risk" and "defense-in-depth" level of fire prevention, fire protection and emergency response that protects the public health and welfare, prevents undue hazards to employees, protects vital production programs, protects the environment and requires that property damage be held to manageable levels. The installation and maintenance of fixed fire protection systems are given the highest priority.

There is a requirement that every major site utilize the services of qualified fire protection engineers to ensure the highest economically justifiable level of industrial loss prevention and protection. This professional expertise is the prime means of ensuring that loss potentials are properly identified and analyzed, modern loss control programs are developed and implemented, risk and vulnerabilities are communicated to DOE and management, losses and trends are investigated and that fire protection systems are inspected, tested, and maintained adequately to ensure operability.

The record could not be sustained and be successful without the dedicated service of the onsite fire departments at each major facility. They provide the day-to-day management of the fire protection systems, inspections and testing of fire protection systems and emergency equipment, emergency preplanning and incident command, fire prevention training, hazardous materials response, emergency medical response, hazardous operations monitoring, and ensure a 24-hour per day first response to all site emergencies. The highly trained and skilled fire department cadre are assisted by site emergency squads to provide additional personnel at major sites.

Strong leadership is provided by ORO to ensure contractors have programs in place which meet DOE requirements with the Safety and Health Division providing oversight, technical support, and policy development. Line organizations are delegated the responsibility to implement the fire protection programs.

ELEMENTS OF THE FIRE PROTECTION POSITION



II. FIRE PREVENTION AND PROTECTION PROGRAM ELEMENTS

DOE Order 5480.7A, Fire Protection, directs the Oak Ridge Operations Office and contractors to manage and operate facilities sufficient to fulfill the requirements for the best protected class of industrial risks characterized as "Highly Protected Risks." The program is based upon a continuous and sincere interest by management and employees to minimize losses, the support of professional fire protection engineering and fire department staffs, and compliance with applicable codes and standards.

In addition to the fact that DOE sites are non-insured, there are several important differences between DOE requirements and those private industry or NRC licensed facilities. These differences include: (1) DOE emphasis of employee Life Safety, (2) high level concern for public health and safety and protection of the environment, (3) DOE is responsible for funding improvements, the responsible care of public funds, and the cost-benefits of needed improvements, (4) DOE is involved in the production and care of national security related materials that may justify higher levels of protection, and (5) all major sites are required to maintain professional fire protection engineering and fire department staffs.

The following are program elements necessary for an acceptable Oak Ridge Operations Office fire prevention, protection, and suppression program:

COGNIZANT ENGINEER/AUTHORITY HAVING JURISDICTION

Within the management and operations contractor organization providing fire prevention and protection activities, there shall be one qualified person at each major site who is designated by site management as the "authority having jurisdiction (AHJ)" with clear and formal delegation of responsibilities. Serving as a DOE/contractor point of contact, this person shall be delegated responsibility, authority, and adequately staffed for: (1) the identification and evaluation of fire safety problems, (2) the development of fire prevention and loss control programs, (3) the communication of fire safety information, and (4) the measurement of fire safety performance.

This person shall function as the source of routine interpretation for facility management and mandatory codes, standards, and regulations. They shall be assigned and ensured the responsibility and authority to communicate freely and candidly with the Oak Ridge Operations Office fire protection staff to facilitate highly protected risk level of protection at all times. The Oak Ridge Operations Office Safety and Health Division is the authority having jurisdiction for all final and controversial decisions as delegated by ORIG 5480.7A.

The qualifications for the person designated as the "Authority Having Jurisdiction" shall be as specified with DOE Order 5480.7A, section 7, (m) "Qualified Fire Protection Engineer."

The person functioning as the authority having jurisdiction at each major site must ensure that:

1. Proper fire protection design review, installation, and acceptance testing are provided for all new construction and applicable modifications.

2. Risk and vulnerabilities are identified, communicated to management and DOE, and that there is adequate fire protection throughout the facility.

3. Necessary inspection, testing, and maintenance of fire apparatus, fixed fire protection systems, water supplies, and alarm systems, are performed and documented to ensure reliable operation.

4. Sufficient trained emergency response personnel are available to handle any credible fire emergency at the facility.

5. That compliance with mandatory DOE standards and regulations are enforced pertaining to:

   (a) The prevention of fires;
   (b) The suppression or extinguishing of hazardous fires;
   (c) Fire protection for the storage, use, and handling of flammable and other hazardous materials;
   (d) The installation and maintenance of automatic and manual fire alarm and fire extinguishing equipment;
   (e) The installation and maintenance of emergency egress systems;
   (f) The investigation of the causes and lessons learned of fire, explosions, and related perils.

6. Compliance with DOE mandatory standards and an effective program of "Highly Protected Risk" are accomplished at the most reasonable cost.

HIGHLY PROTECTED RISK CONCEPT

The "Highly Protected Risk" concept is similar to the defense-in-depth principles used within nuclear power plants to achieve the required high degree of fire safety using echelons of safety programs and systems. The "Highly Protected Risk" concept has been adopted because long standing experience has proven that it results in minimal losses due to fire and related perils while ensuring reasonable costs as follows:

(a) Fire prevention activities;
(b) Fire protection systems and engineering controls that detect fires quickly and automatically suppressing/controlling those fires that do occur quickly, and limiting damage to a minimum;
(c) Providing effective emergency response and manual fire suppression capabilities to manage and supplement the engineered fire protection features.

No one of these echelons can be perfect or complete by itself. Strengthening any one can compensate in some measure for weaknesses, known or unknown, in the others. Elements of a "Highly Protected Risk" program of fire protection are outlined with DOE Order 5480.7A, Fire Protection.

Qualified fire protection engineering judgements shall be used to obtain the highest degree of fire protection consistent with reasonable economical costs. Reasonable protection shall be provided to ensure that hazards to life are minimized, prevent fires to minimize the potential for off-site release of contamination, that vital programs will not suffer unreasonable delays, and that the maximum credible fire or explosion loss will not exceed $1,000,000. If a higher standard of protection is justified, the credible fire loss should be limited to $250,000. Management and Operating Contractors at all major sites shall maintain and support a cadre of qualified fire protection engineers to provide effective management oversight, planning, and decisions.

ECONOMY OF PROGRAM

When providing fire protection systems, not only must the initial costs be considered, but the complexity and frequency of inspections, tests, maintenance, and life cycle costs must also be evaluated. Since direct labor is practically all of the recurring program costs, efficient use of personnel should be ensured. Strong management control and workload evaluations are needed to ensure efficient operations. Attachment "A" is typical workload analysis that should be kept up-to-date and made available at functional appraisals. Sufficient personnel shall be maintained to ensure compliance with required inspection, test, and maintenance frequencies.

At sites maintaining industrial fire departments, it is expected that sites utilize personnel within the fire department operations to the maximum extent possible for test, inspection, and maintenance activities. Not only does this contribute to the economy of the programs but it also ensures that ownership and knowledge of the fixed fire protection system resides in those who most depend on it for their own safety, and the safety of others, in time of emergency.

EMERGENCY RESPONSE

At all major sites, the first response to all emergencies is performed by the site Fire Departments. Primary duties of each Fire Department may include fire fighting, incident command (tactical), Haz-Mat response, spill control, emergency medical response, search and rescue, confined space rescue, vehicle extraction, radiation monitoring, and other duties necessary to mitigate an emergency.

The management and operation of DOE facilities places an important responsibility upon those charged with their protection. Under provisions of their contract, management and operating contractors are required to "maintain security and fire fighting forces to the extent required by DOE." Subsequently, the Department requires compliance with OSHA standards and NFPA 1500, Fire Department Occupational Safety and Health.

Under the provisions of NFPA 1500 (Section 6-4.1), it is required that; "The fire department shall provide an adequate number of personnel to safely conduct emergency scene operation;" this is interpreted by the Department as follows:

> "The minimum response requiring interior fire fighting or other operations requiring the entrance of self-contained breathing

apparatus (SCBA)-equipped people shall be five persons. When less personnel are available, interior operations shall not be attempted." (Memorandum dated March 12, 1990, R. Barber, Acting Deputy Assistant Secretary to Field Offices)

☞ *Members who arrive on the scene of a working structural fire prior to the assembling of five persons may initiate exterior actions in preparation for an interior attack. These may include, but are not limited to, actions such as the establishment of a water supply, the shutting off of utilities, the placement of ladders, the laying of the attack line to the entrance of the structure, or exposure protection. If members are going to initiate actions that would involve entering of a structure because of an imminent life-threatening situation where immediate action may prevent the loss of life or serious injury, and five members are not yet on the scene, the members should carefully evaluate the level of risk that they would be exposed to by taking such actions. If it is determined that the situation warrants such action, incoming companies should be notified so that they will be prepared to provide necessary support and backup upon their arrival. Such action is intended to apply only to those rare extraordinary circumstances when, in the member's professional judgment, the specific instance requires immediate action to prevent the loss of life or serious injury and five persons have not yet arrived on the fireground. (adapted from NFPA "Tentative Interim Amendment")*

The criteria stated above are minimum levels only. In order to supplement the emergency response effort, it has been long standing policy within major management and operating contractors to supplement the professional fire department organization with emergency squad personnel from other shift operations. A 1964 memorandum from the manager of Oak Ridge Operations to the United States General Accounting Office stated the following:

> "The minimum acceptable fire fighting response is a two-company capability with minimum of 10 qualified persons available since these facilities are of extremely high value and vital importance.....rather than maintain a 10-person fire company on each of the respective shifts, training programs have been established of sufficient quality, depth, and reliability to ensure that the balance of the fire fighting manpower required is available from other personnel within the respective shifts. This is commonly referred to as a plant fire brigade."

Mutual aide agreements and call-in protocols are used to supplement response levels but should not be depended upon for vital first response efforts. Threat assessments should be documented at each site that identify the creditable and possible emergency situations and the respective resources necessary for mitigation.

ATTACHMENT "A"

EXAMPLE WORKLOAD SCHEDULE

Type of Unit	Number of Units	Frequency of Inspection	Description of Inspection	Number of Persons	Average Time Per Unit	Hours Per Year
Sprinkler Systems						
Wet Pipe	131	Weekly*	Visual	1	10 Min.	873
		Semiannually	Oper., & Flow Test	2	20 Min.	175
Dry Pipe	46	Weekly*	Visual	1	10 Min.	307
		Semiannually	Flow Test	2	20 Min.	61
		Annually	Oper. Trip Test	2	2 Hrs.	184
		Annually	Hydro Test - Air Compressor Tank	1	2 Hrs.	92
Waterfog	54	Weekly*	Visual	1	10 Min.	360
		Semiannually	Oper., Heat and Flow Test	2	2 Hrs.	216
Sprinkler Antifreeze	39	Monthly	Visual	1	Included in Sprinkler Inspection	
		Annually	Test Solution	1	30 Min.	20
		Each 5 years	Solution Change	2	2 Hrs.	30
CO_2 Systems						
Hi-Pressure	14	Weekly*	Visual	1	10 Min.	93
		Semiannually	Weigh Cylinders	2	6 Hrs.	336
		Annually	Operational	3	4 Hrs.	168
Dry Chemical Systems	2	Weekly*	Visual	1	10 Min.	13
		Semiannually	Operational (pressure switch only)	2	20 Min.	3
			Weigh Cylinders	2	2 Hrs.	16
		Each 10 years	Hydrostatic Test	2	2 Hrs.	

*One week per month included in building inspection.

SAMPLE SHEET ONLY

ATTACHMENT "A CON'T"

SIZING THE FIRE DEPARTMENT FORCE BY WORKLOAD MEASUREMENT

- Labor effectiveness - Because of delays and inefficient labor practices no work force is completely effective. If a work force operates at an effectiveness level of 70 percent, 30 percent more labor effort is required to do the estimated work. Therefore, basic person-hour figures must be multiplied by 1.3 to obtain the number of person-hours required when the work force is 70 percent effective.

- Hours per person per year - If a person worked an 8 hour day 5 days a week, 52 weeks a year, they should contribute 2080 person-hours (PH) per year. But vacation, sick leave, and holidays must be subtracted from this figure. For example:

  Vacation = 20 days
  Holidays = 8 days
  Sickness = 7 days

  Total = 35 days x 8 hr./day = 280 PH/year

  Thus,

  2080 - 280 = 1800 PH/year

  The number of persons required for coverage may be found by dividing the total person-hours required by 1800.

- Shift Coverage - One person can cover five shifts a week. The number of persons needed for a seven shift operation can be computed by multiplying the five shift requirement by 1.4.

TABULATING WORKFORCE NEEDS

Work Category	A Estimated PH	B PH @ 70% Effectiveness (A x 1.3)	C No. of persons 5 day coverage (B - 1800)	D No. of persons 7 day coverage (C x 1.4)
Inspection	6,000	7,800	5	7
Testing	8,000	10,400	8	11
Training				
- fire	1,000	1,300	1	2
- ambulance	1,000	1,300	1	2
Emergency				
- fire	500	650	1	2
- ambulance	600	780	1	2
Repetitive	7,000	9,100	5	7
TOTAL	24,100	31,330	22	33

III. FIRE PROTECTION ACCIDENT AND IMPAIRMENT NOTIFICATION GUIDES

Oak Ridge Operations Office requests notification of fire, explosions, related accidents, and significant impairments of fire protection systems regardless of the magnitude. By having such losses and impairments reported, it is hoped that the situation is prevented where a number of unreported losses precede a large or significant loss. It is believed that proper attention, possibly involving an engineering assessment by knowledgeable staffs, can result in a level of fire protection or attention which will minimize the chance of recurrence. This information will also be used to determine trends within the OR Operations Office.

At Government-owned Contractor-operated facilities, it is a vital responsibility that information concerning issues relating to the health and safety of the public, employees, Government owned facilities, and the environment be reported in a timely, clear, and precise manner by Contractors.

This guide establishes the reporting requirements expected of Contractors under the Oak Ridge Operations Office.

FIRE, EXPLOSION, IMPAIRMENT AND RELATED PERILS NOTIFICATION GUIDES		
NOTIFICATION WITHIN 2 HOURS	**NOTIFICATION WITHIN 8 HOURS**	**NOTIFICATION WITHIN 24 HOURS**
ANY FIRE/EXPLOSION ABOVE $10,000.	IMPROPER IMPAIRMENT OF A FIXED FIRE PROTECTION SYSTEM IS DISCOVERED.	MOBILE FIRE DEPARTMENT APPARATUS OUT-OF-SERVICE: 1. 1 UNIT - >48 HRS 2. 2 UNITS- >24 HRS 3. 3 UNITS- > 8 HRS
FIRE/EXPLOSION THAT RELEASES RADIOACTIVE OR CHEMICAL CONTAMINATION OUTSIDE A BUILDING.	ADEQUATE FIREWATER SUPPLIES UNAVAILABLE.	AUTOMATIC FIRE WATER PUMP OUT-OF-SERVICE. NOTIFY: IF IMPAIRMENT EXCEEDS >24 HRS
FIRE/EXPLOSION THAT RESULTS IN SPREAD OF CONTAMINATION OFF-SITE.	UNDERGROUND FIRE WATER WATER SUPPLY PIPING BREAK. (6 IN. OR LARGER PIPE) NOTIFY: IF IMPAIRMENT EXCEEDS >48 HOURS.	OTHER TYPES OF LOSS OR IMPAIRMENT NOTIFY: AS APPROPRIATE

INCENDIARISM OR MALICIOUS INTENT IS SUSPECTED.	GRAVITY FIRE WATER SUPPLIES OUT-OF-SERVICE. NOTIFY: IF IMPAIRMENT EXCEEDS >8 HOURS.	FIRE ALARM SYSTEM, 25% OR MORE, OUT-OF-SERVICE. NOTIFY: IF IMPA IRMENT EXCEEDS >24 HRS
FIRE/EXPLOSION/OR RELATED INCIDENT INVOLVING A NUCLEAR WEAPON DEVICE.	FIRE/EXPLOSION/RELATED INCIDENT ABOVE $1000.	MAJOR IMPAIRMENT OF FIXED FIRE PROTECTION SYSTEM. (SPRINKLERS, CO_2 HALON. DRY CHEMICAL) NOTIFY: IF IMPAIRMENT EXCEEDS >24 HOURS.
ANY FATAL INJURY INVOLVING FIRE OR EXPLOSION.	FIXED FIRE PROTECTION SYSTEM ACTIVATED AS THE RESULT OF A FIRE OR EXPLOSION.	INCIDENT INVOLVING LESSONS LEARNED FOR OTHER SITES.
HOSPITALIZATION OF FIVE OR MORE EMPLOYEES	HOSPITALIZTION OF ONE OR MORE EMPLOYEES	

NOTES: Notification of fire, explosion, or related incidents, and emergency impairments should be made by phone or fax to the to the Oak Ridge Operations Emergency Operations Center.

This guide supplements and does not replace reporting requirements listed eleswhere within other DOE Orders.

IV. FIRE PROTECTION PLAN REVIEW

A. Purpose

This section establishes uniform requirements for review of design specifications/criteria, construction specifications, and drawings prior to contemplated construction to ensure adequacy of fire risk appraisal and protection sufficient to attain the objectives listed in DOE Order 5480.7A.

B. Definitions

1. System of Internal Control

   a. A plan of organization which provides appropriate segregation of functional responsibilities.

   b. A system of independent approval and documentation to provide reasonable control over fire risks and fire safety expenditure.

   c. Sound practices to be followed in performance of duties and functions of each organizational component.

   d. Personnel of a quality commensurate with responsibilities.

C. Procedure

1. DOE/ORO Safety and Health Division, Nuclear Safety Team

   a. Conduct periodic appraisals to ensure that a viable system of internal control for review of plans is in effect at those facilities which employ in-house fire protection engineering staffs.

   b. Audits documentation files on fire protection plan review.

   c. Provide review and advice to contractors and DOE/ORO staffs in need of assistance or who do not have their own fire protection staff.

   d. Act as "the authority having jurisdiction" when controversial issues arise.

2. DOE/ORO Contractors

   a. Establish a documented system of internal control for protection plan review prior to contemplated construction or modifications.

   b. Utilize transmittal sheet, letter, memo, E-mail, or DOE Form No. 1, Design Review Record, to document all design reviews for new buildings or major modifications.

2. DOE/ORO Contractors (continued)

c. Maintain the design review record, etc., and resolution/actions to be taken on comments for the periodic fire protection appraisal.

d. Routinely acts as "the authority having jurisdiction."

D. Typical Design Material To Be Reviewed And Commented

(No such list can ever be entirely complete or meet the need of every situation.)

1. Site drawings and site utility drawings

- Accessibility
- Flood Control
- Emergency Personnel/Equipment Deployment
- Environmental Control
- Process, Equipment, Material Spacings
- Water Supplies
- Firewater Mains
- Hydrants
- Flammable Liquid Spill Control
- Gas Distribution Systems
- Hazardous Material Traffic Routes
- Fencing Locations

2. Architectural drawings

- Building Code Compliance (Fire Protection)
- Roof Drains
- Emergency Egress (Life Safety)
- Storage, high piled, records, tapes
- Fire Walls, Openings, Fire Doors, Fire Door Hardware
- Access Ladders
- Flammable/Combustible Liquid Facilities
- Explosion Relief
- Fireproofing
- Materials of Construction
- Maximum Loss Potential
- Extinguisher Location
- Accessibility for Emergency Response
- Hazardous Area Classification
- Smoke Venting
- Storage and Warehousing
- Combustible Dust Handling
- Roof Construction
- Interior Finishes
- Construction Materials (i.e., framing, insulation, wall coverings, and ceiling materials)
- Elevators

3. Pipe drawings

- Automatic Sprinklers
- Hose Standpipe Systems
- Fixed Extinguishing Systems, CO_2, Gaseous Agent, Dry Chemical, Foam, Water Mists, Water Spray
- Hazardous Material Distribution
- Emergency Venting
- Tank Car/Truck Loading and Unloading
- Underfloor drains for Computer Facilities
- Backflow Preventers

4. H&V drawings

- Fire Dampers
- High Temperature/Smoke Interlocks
- Materials of Construction
- Access Ports
- Fixed Protection Requirements
- Insulation Fire Rating
- Flammable Vapor Removal (Air Change Rates, Bonding and Grounding, Pickup Points, Explosion Proof Design, etc.)

5. Electrical drawings

- Hazard Classification (NEC Article 500)
- Fire Alarm and Detection Systems (Waterflow and Supervisory)
- Emergency Evacuation/Notification Systems
- Accessibility of Equipment
- Emergency Lighting and Power
- Lightning Protection
- Cable Tray Design
- Essential Equipment Water Shielding and Diking
- Transformer Protection and Fluids
- Fire Alarm Pull Boxes
- Smoke Detection, Heat Detection, Flame Detection
- Grounding

6. Other

- Fire Water/Criticality Concerns
- Coded Vessels Properly Vented
- Combustion Controls
- Combustible Dust Hazards
- Pipeline Identification
- Reactive Material Handling
- Compressed Gases
- Hazard Communication
- Pollution Control Fire Risks
- Conveyor Systems
- Chemical Compatibility
- Flammable Gas Monitoring
- Fire Water Run-off
- Communications

6. Other (continued)

- Special Extinguishing Systems, Halon, CO_2, Dry Chemicals, etc.
- Mutual Aid
- Inert Gas Blanketing
- Flammable/Combustible Material Identification
- OSHA Fire Safety Requirements
- Spill Containment

7. Specifications

- Funding
- Written Fire Protection Plans
- Timely Installation of Protection
- Hot Work Controls and Permits
- Material Storage
- Temporary Trailers
- Temporary Fuel-Fired Heating
- Accessibility
- Test and Acceptance Procedures/Certifications
- Protection Impairment Procedures
- Hazardous Material Use During Construction

UNITED STATES DEPARTMENT OF ENERGY OAK RIDGE OPERATIONS	DESIGN REVIEW RECORD Plant
Project Title _____ Job Title _____ A-E Transmittal ____ ____ ____ ____ ____ No. Date Log No. Rec. Due Out	A-E _____ Dept. _____ Status Review _____

ITEM NO.	DRAWING OR SPEC. NO. & PARAGRAPH	COMMENTS	AE ACTION

Reviewed By Date	Recommended By Date Operating Contractor	Authorized By Date DOE Engineering	A-E

PAGE ____ OF ____

DOE FORM 1

V. FIRE HAZARDS ANALYSIS

Purpose: Comprehensively assess and document the risks and vulnerabilities from fire and explosions perils within individual facilities to assure compliance with the objectives of DOE Order 5480.7A, "Fire Protection" and to ensure DOE management that the risks can be safely controlled.[1] A graded approach commensurate with the risk should be utilized.

Where:

- All new construction,[2]
- High (category 1) and Moderate (Category 2) Hazard Facilities, as designated by the SAR process.[3]
- As directed by the Program Office, i.e., when existing fire protection is to be abandoned due to decommissioning and demolition status.

What: A fire hazards analysis is a comprehensive document that addresses for selective risks all the information necessary to incorporate or complete the following fire/explosion safety information:

(1) Description of the overall facility fire protection/department program.
(2) Fire Protection Engineering Self-Assessments[4]
(3) Deficiencies and Recommendations
(4) Fire Hazards Analysis Elements listed within DOE Order 5480.7A, "Fire Protection."
(5) Special analysis commensurate with the risks should be integrated into the FHA's, for example:
   a) code compliance audit;
   b) process hazard analysis (PHA) per OSHA 1910.119;
   c) Risk Management Plan under EPA/RCRA;
   d) Hazards Assessment under the Clean Air Act Amendments of 1990;
   e) Safety Analysis Report (SAR);
   f) Design Analysis for new construction.

How: A graded approach shall be utilized to perform fire hazard analysis.[5] Graded approach means a process by which the level of analysis, documentation, and actions necessary to comply with a requirement are commensurate with:

(1) The relative importance to fire and explosion safety;
(2) The magnitude of any hazard involved;
(3) The life cycle stage of a facility;
(4) The programmatic mission of a facility;
(5) The particular characteristics of a facility, and
(6) Any other relevant factor.

Tools: The following tools at the Contractors discretion and that are appropriate for the risks involved may be used to determine and evaluate the hazards of processes being analyzed:

(1) Code compliance review or checklist;
(2) Hazard and Operability Study (HAZOP);
(3) Failure Mode and Effects Analysis (FMEA);
(4) Fault Tree Analysis;
(5) Validated Fire Models
(6) Handbook of Chemical Hazard Analysis Procedures[6];
(7) Management Oversight and Risk Tree Analysis (MORT);
(8) An appropriate equivalent methodology.

When:

(1) Consistent with OSHA 1910.119, Process Safety Management of Highly Hazardous Chemicals; Explosives and Blasting Agents fire hazards analysis should be integrated into the requirements for process safety.

(2) Fire hazards analysis should be updated and revalidated when major changes occur or the SAR is rewritten to assure that the analysis is consistent with the current risks.

(3) Fire hazards analysis should be performed for all new construction and for modified facilities when the modification is significant enough to require a change in nuclear or highly hazardous chemical process safety.

The fire hazard analysis for new construction shall be initiated early in Title I design and finalized prior to the completion of Title II design activities.

(4) Each site shall maintain a list of facilities and frequency where fire hazard analysis will be performed. A new or updated FHA will satisfy the requirements for performing one frequency of a fire protection assessment.

Who:

(1) The preparation of the Fire Hazards Analysis should be performed and/or coordinated by qualified fire protection engineer(s) and reviewed and approved by the site "authority having jurisdiction."

(2) The cognizant plant fire protection engineering group should maintain all fire hazards analysis information on file.

General guidelines

- o Keep it simple yet technically sound;
- o Use a graded approach and incorporate analysis performed by other teams.
- o Use in-house expertise and avoid consultants;
- o phase-in and set priorities;
- o continually improve;
- o train personnel in hazards analysis tools;
- o Where applicable, use teams and include employee participation;
- o seek out advice from customers.

1. Joseph E. Fitzgerald, Jr & Neal Goldenberg. "Guidance on Performance of Fire Hazards Analysis." U.S. DOE Memorandum, Nov 7, 1991.

2. "General Design Criteria." U. S. DOE Order 6430, April 6, 1989, section 0110-6.2, pp. 1-55 & 1-56.

3. DOE Order 5481.1B, "Safety Analysis and Review System for Nonnuclear facilities and DOE 5480.23, "Nuclear Safety Analysis Reports for Nuclear Facilities.

4. DOE Order 5480.7A, "Fire Protection," U. S. Department of Energy, Washington, D.C., Feb. 1993.

5. "10 CFR Part 830-Nuclear Safety Management," Federal Register/Vol. 59, No. 65/Tuesday, April 5, 1994.

6. "Handbook of Chemical Hazard Analysis Procedures." Automated Resource for Chemical Hazard Incident Evaluation (ARCHIE), U. S. DOT, FEMA, EPA.

VI. DETERMINATION OF MAXIMUM CREDIBLE/POSSIBLE FIRE LOSS

SCOPE

This section provides guidelines and references for maximum possible fire loss, fire walls and space separation. DOE 6430.1A and 5480.7A addresses maximum possible fire loss areas.

MAXIMUM CREDIBLE LOSS

The maximum loss that could occur from a combination of events resulting from a single fire. Considerable judgment is required to evaluate the full range of potential losses, but in general, readily conceivable fires in sensitive areas are considered. Examples are power wiring failures in cable trays, flammable liquid spills, and high value parts storage areas or combustible exposures to sensitive machines. Any installed fire protection systems are assumed to function as designed. Due to uncertainties of predicting human action, the effect of emergency response is generally omitted except for post-fire actions such as salvage work, shutting down water systems, and restoring production.

MAXIMUM POSSIBLE LOSS

The maximum possible loss that could occur in a single fire area assuming the failure of both automatic and manual fire extinguishing actions.

CRITERION

The "Highly Protected Risk" level of protection requires that the "maximum possible fire loss" shall be the basis for determining the need to provide automatic fire suppression systems and for additional fire protection systems and features. The application of these criteria shall be considered by an experienced fire protection engineer.

Whenever the maximum possible fire loss exceeds $50 million, the area shall be subdivided with fire rated barriers or suitable redundant fire protection systems to limit the credible loss to less than $50 million even in the event the primary system fails. In no case shall the maximum loss potential exceed the $150 million loss limit established in DOE 5480.7A; passive systems such as physical separation or rated fire walls shall be provided to prevent this possibility.

STANDARDS AND REFERENCES (LATEST EDITIONS)

- DOE 5480.7A FIRE PROTECTION & ORIG
- DOE 6430.1A GENERAL DESIGN CRITERIA
- UNIFORM BUILDING CODE OR OTHER APPROPRIATE BUILDING CODE
- LIFE SAFETY CODE, NFPA 101

- DOE/EV-0108 STANDARD FOR FIRE PROTECTION ON DOE ELECTRONIC COMPUTER/DATA PROCESSING SYSTEMS

- DOE/EV-0034 STANDARD ON FIRE PROTECTION FOR PORTABLE STRUCTURES

- FACTORY MUTUAL DATA SHEET 1-22 CRITERIA FOR MAXIMUM FORESEEABLE LOSS FIRE WALLS AND SPACE SEPARATION

IMPLEMENTATION

- Fire protection design analysis for new facilities, including maximum loss potentials, shall be done as soon as possible and included as a portion of the Title 1 Design Summary document required by DOE 6430.1.

- All facilities shall include in their periodic fire protection engineering assessments the maximum loss potentials and special fire prevention and protection features and controls deemed necessary by qualified fire protection engineers to achieve a level of highly protected risk fire protection.

- Safety analysis reports should include maximum loss potentials and other analysis required in that program.

VII. GENERAL GUIDES FOR AUTOMATIC SPRINKLER SYSTEMS

1. DOE Orders 5480.7A, Fire Protection and 6430.1A, General Design Criteria states the objectives and criterion in justifying automatic sprinkler system installations. The application of these Orders shall be considered by qualified fire protection engineers.

2. Each sites designated "authority having jurisdiction" are responsible for the establishment, maintenance, and enforcement of the system requirements for its fire protection and detection systems. Such criteria are to be reviewed and approved by the plants' cognizant Fire Protection Engineering Organization.

   Issues related to code interpretation, exemptions, design approvals, acceptance testing, and other other issues which cannot be resolved by the Plant Fire Protection Engineering Organizations shall be referred to the DOE/ORO cognizant fire protection engineer for resolution as the final "authority having jurisdiction" defined by NFPA Standards.

3. The traditional approach for sprinkler design and installation is the **pipe schedule system** where each pipe is sized according to the number of sprinklers that it supplies. This type of system has considerable flexibility and provides adequate protection with the strong water supplies provided at most DOE sites. Pipe schedule systems that are newly installed, or major modifications, should be hydraulically calculated to verify flow and pressure at the base of the riser at the direction of the AHJ.

   Hydraulically designed systems are now required for sites where limited water supplies are available. For new system designs, the flow and pressure required at the base of the riser will not be known until the system is designed. Therefore, it is necessary to estimate the minimum flow and pressure required to design the system.

   The base-of-riser pressure should be selected as follows:[1]

   * Where a density of 0.30 gpm/sq. ft. for 3000 sq. ft. or less is needed, the residual pressure available at the estimated demand should be at least 50 psi.

   * Densities above 0.30 gpm/sq. ft. should have a residual pressure available at the estimated demand of at least 75 psi.

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[1] "Estimating Fire Protection Water Demands," IRInformation, Industrial Risk Insurers, IM.14.1.1.0, June 1, 1992.

* Where the building is more than one story, add additional pressure to account for the extra elevation loss.

* Where large drop or ESFR sprinklers are to be used, the high discharge pressure at the sprinkler may require pressures greater than 75 psi at the base of the riser.

* Water is not distributed evenly to all sprinklers, and the theoretical flow rate must be increased by 10 percent or more before it can be used as an estimate.

* Consider future developments that may decrease the strength of the underground water supplies.

4. Light hazard design or pipe schedule shall not be used.

5. Standard wet pipe automatic sprinkler systems should always be given first consideration. Use of pre-action, on-off systems, deluge sprinkler systems, foam-water, should be reserved for special consideration and hazards only.

   The more technically sophisticated hardware now available requires a more sophisticated level of inspection, testing, and maintenance. Such attention may not be provided or available in every instance. In choosing the type of sprinkler system to be installed, consideration must be given to the level of maintenance and support that will realistically be provided as the years go by, with the objective of providing a continuously reliable system.

6. Light wall, thin wall, and plastic pipe shall be used only with the specific written approval of the DOE-ORO authority having jurisdiction.

7. All change of directions for underground fire water mains should be restrained by both thrust blocks and coated tie rods or mechanical retention joints.

8. For small jobs or system modifications where the number of sprinkler heads is 39 or less, the designated agent (qualified A-E or M&O Contractor) is responsible for design of the system. Where 40 or more sprinkler heads are involved, the designated design agent will prepare a performance type specification and other support documentation, as required, for design and installation by a qualified sprinkler contractor licensed for such work.

   State law, and most building codes, require that sprinkler systems be designed by either a licensed architect or engineer, or a NICET Level 3 certified "responsible managing employee." It is preferred that all sprinkler systems be designed by a State registered sprinkler contractor.

Also, under State law "A sprinkler contractor must install all fire protection service lines from the point of service which begins immediately after the tap of the service main where water is used exclusively for fire protection purposes."

9. Torch cutting/welding is not permitted to field modify or repair existing sprinkler systems. Torch cutting/welding may be permitted for new construction where proper precautions are specified and enforced by contract provisions and proper safety work permits.

10. Prior to system fabrication for installation or modification, all design documentation required by NFPA standards must be submitted for review and approval to the site design organization and Fire Protection Engineering Group. Any deviation form the approved documentation must be by written approval of the approving organization.

11. If retard chambers are provided, there should be no valve between the alarm check valve alarm port and the retard chamber and alarm switch.

    Paddle-type alarm devices are not recommended on main risers. Pressure switches attached to an alarm-check valve, dry-pipe valve, or deluge valve are preferred.

AUTOMATIC SPRINKLER SYSTEMS RESPONSIBILITIES:

The following identifies primary responsibilities of the management and operating contractor, DOE Operations Office, and sprinkler designers/installers.

COGNIZANT PLANT FIRE PROTECTION ENGINEER

* Establishes system requirements
    - o Identifies details of the specific occupancy and classifies the occupancy under the sprinkler code.
    - o Determines the density and area of application needed for the specific occupancy. Also considers the need for in-rack sprinklers, maximum reliability, or other special supply and valving arrangements, and the amount of water needed for hose stream allowances.
    - o Provides water supply data to the design organization after taking into consideration fluctuations in pressure, volume or both due to other water demands.
    - o Functions as the Authority Having Jurisdiction
* Reviews Plans and Supporting Data.
    - o Under closed head systems, verifies proper application of specifications to the hydraulically most demanding rectangular area having a dimension parallel to the branch lines equal to or greater than 1.4 times the square root of the area of operation.
    - o Verifies water supply information, taking into consideration fluctuations in pressure, volume or both from process demands.
    - o Checks adequacy of flow demand at the base of the riser.
    - o Verifies water supply can meet both sprinkler and hose demand.
    - o Comments to the designer and files the comments for review during DOE/ORO appraisals.
    - o Periodically audits a sampling of computer designed sprinkler submittals.
* Review Completed Sprinkler Installations.
    - o Verifies installation with "approved" contractor's drawings. Deviation from these drawings may require recalculation or repiping to the originally approved design.

- o Verifies that installation meets or exceeds NFPA requirements.

- o Verifies installation of placard indicating location protected, the basis of design and the demand at the base of the riser.

- o Verifies that all flushing, hydrostatic, and operational tests are performed by the installing contractors before the system is accepted.

Sprinkler Contractors, Design Engineers, A/E's

* Designs sprinkler systems that:

  - o Produce the levels of protection specified by the site cognizant fire protection engineer/customer.

  - o Have pressure/flow demands that are within the capability of existing or proposed water supplies, simultaneous with hose demands.

  - o Meet the design and installation requirements of applicable NFPA standards and other DOE requirements.

  - o Prepare installation drawings and hydraulic calculation sheets for review and approval.

  - o Installs protection in accordance with approved plans.

  - o Submit properly signed and witnessed "Contractor's Test Certificates" after completing the following:

    -Flushing of underground before connecting sprinkler systems.

    -Hydrostatic testing of all newly installed underground and interior piping in accordance with applicable NFPA standard.

    -Conducting operating tests on all newly installed equipment to verify successful performance.

  - o Accept responsibility for errors in design or installation which prevent the system from meeting the design specifications.

DOE/ORO Fire Protection Engineer

Periodically audits the design review and approval process. Acts as the "Authority Having Jurisdiction" for any non-routine controversy.

U.S. Department of Energy ENVIRONMENT, SAFETY & HEALTH Washington, D.C. 20585

BULLETIN

Assistant Secretary, Environmental Protection, Safety & Emergency Preparedness
Office of the Deputy Assistant Secretary for Environment, Safety & Health

DOE/EP-0031/5 BULLETIN NO. 5 September 1982

NEW STUDY DOCUMENTS RELIABILITY OF AUTOMATIC SPRINKLER SYSTEMS

For over 30 years, the automatic sprinkler system has been routinely installed in the conventional laboratory, office, manufacturing plant, and storage facility now operated for the Department of Energy. Sprinklers are the most common protection system installed in computer rooms, reactor control rooms, electrical equipment rooms, and areas where the principal hazard is from nuclear criticality or radioactive contamination. A new study (DOE/EP-0052), which documents our experience from 1952-1980, makes it clear that our continued reliance on the automatic sprinkler system as the basic fire protection system is amply justified.

The study is timely. In recent years, new types of fire protection systems have prolifered, new requirements for emergency forces have been imposed, and the philosophies of safety analysis and risk projection have enjoyed major advances. At the same time, there have been some articles questioning the historic efficiency of the admittedly complex problem of loss protection. Although there have been a number of individual incidents where the sprinkler system undoubtedly prevented much larger losses (including one that probably repaid the cost of every sprinkler system installed in the agency's history), installations have been made more on the basis of hazards analyses and comparable industrial and insurance company experience than an actual agency experience.

If the purpose of the study were only to confirm the value of the automatic sprinkler system as a fire protection tool, it would serve little purpose. The Department of Energy needs no convincing as to the value of sprinklers: the loss from fire in a sprinklered building is about one-fifth of the loss in an unsprinklered building; there has been no loss of life due to fire in a sprinklered building; a sprinkler system is more than

Automatic Sprinkler System Performance and Reliability in United States Department of Energy Facilities: 1952-1980. June 1982. DOE/EP-0052.

Performance records for automatic sprinkler systems have been known for some time but in-depth studies of the reliability of these systems are rare. This report analyzes the automatic sprinkler system experiences of the United States Department of Energy and its predecessor agencies from 1952-1980. Based on accident and incident files in the Office of Occupational Safety and on supplimentary responses, 587 incidents, including over 100 fires, are analyzed.

Tables, figures, and narratives discuss fire experience by various categories such as number of heads operating, type of system, dollar losses, failures, extinguished versus controlled fires, and types of sprinkler heads. Use is made of extreme value projections and frequency-serverity plots to compare past experience and predict future experience.

Non-fire incidents are analyzed in a similar manner by cause, system type, and failure type. Discussion of "non-loss" incidents and non-fire protection water systems is included.

The report ends with conclusions, recommendations, and appendices listing survey methodology, major incidents, and a bibliography.

Copies of the report have been distributed to category UC-41 (Health and Safety) as published in Standard Distribution for Unclassified Scientific and Technical Reports: DOE/TIC-4500. While the supply lasts, DOE and DOE contractor personnel can get additional copies from the Office of Operational Safety, EP-32, Germantown. The report is also available from the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22161.

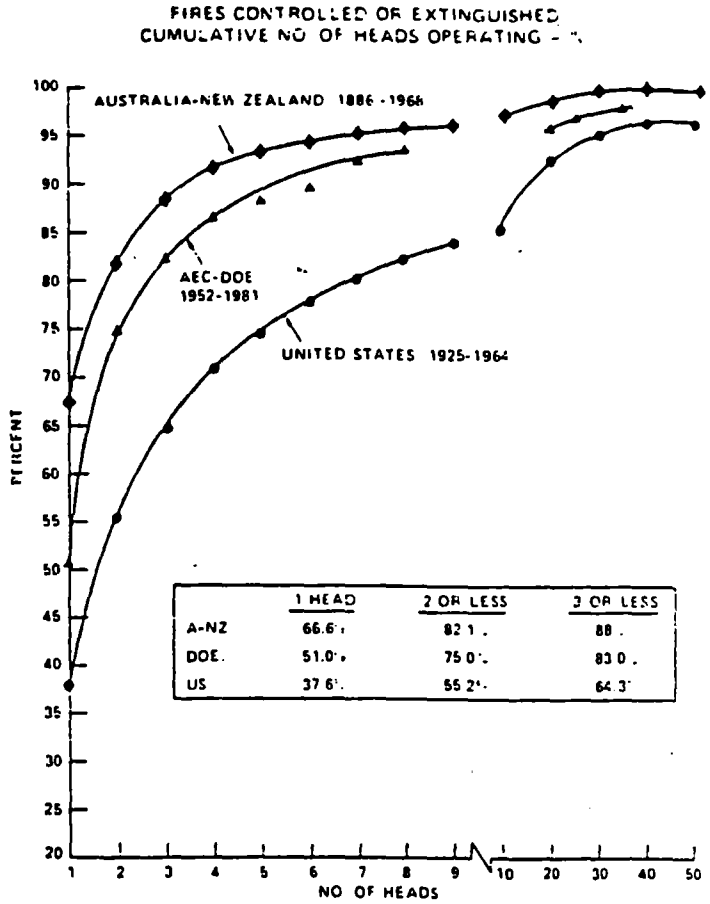
96 percent effective in controlling or extinguishing fires; and about one-third of all fires were completely extinguished by the operation of a single sprinkler head. More important, the large number of non-fire incidents involving sprinkler systems allowed some statistical proof of reliability to be gathered and analyzed; proof that has been all too rare until now.

Since the last bastion of resistance to sprinkler installation involves fears of unreliability in general and water damage in particular, several observations concerning those fears may be the study's most important value. The chance of a sprinkler head failing is about one in a million per year. The frequency of any kind of a non-fire related accident to or from a sprinkler system is about one per year for every 800 systems or about once every 800 years for each individual system — and nearly half of the accidents that occurred were so slight that the damage was negligible. On the basis of actual experience, the damage resulting from the presence of a sprinkler system is less than one percent of the fire damage that would result if the system were not present.

Fire protection water systems are most reliable than other water systems. In DOE's experience, accidents involving ordinary water systems (cooling water for industrial processes, laboratory water supplies, etc.) occur about twice as often as accidents involving fire protection systems. In addition, when an accidental loss to one of those systems occurs, the mean loss, in dollars, is about twice as much as the average fire system loss. This is not surprising, considering that sprinkler installation is a separate mechanical trade and workers installing only sprinkler systems gain more experience and expertise than general contractors. Inspection and test requirements are more rigid (the most common sprinkler hydrostatic test is 200 psig for 2 hours with on allowable leaks) and sprinkler systems are tested and inspected more universally than ordinary water systems.

Water does not normally flow in a sprinkler system, thus the common "wear and tear" of valves, fittings, and pipes is largely eliminated. Sprinkler systems are equipped with waterflow switches that summon the fire department when water flows for any reason so that when accidental leakages do occur, the mandatory waterflow alarms directly notify the proper authority (at most DOE sites, an onsite fire department) and damages can be limited. Since water is normally flowing in other water systems, they cannot be provided with what, in effect, is a 24-hour leak detector!

Paradoxically, the very success of our fire protection program has prevented the accumulation of usable reliability data prior to this report. The cumulative fire loss ratio for the entire Department of Energy, since 1947, is less than 1c for every $100 of value ($100 per million), or about one-third of the loss rate for the "highly-protected risk" class of insurable property. Since 1975, there have been an average of 26 reportable (over $1000 damage) fires per year, including vehicles and brush fires, despite the fact that DOE possesses about $60 billion in plant and equipment values. In fact, since 1970, there have been only two years in which the annual fire loss ratio exceeded 0.25c per $100 of value.



This graph shows the number of sprinkler heads that operated in fires experienced by DOE. Comparison curves are shown for overall U.S. experience and for the reported Australian-New Zealand experience. Both scales are cumulative: i.e., only one head operated in 51% of the fires, one or two heads in 75% of the fires, etc.

One of the conclusions drawn from the DOE study is that the actual performance record of sprinkler systems is better than is generally reported.

The Australian-New Zealand experience is the best reported performance record covering a large number of fires over a long period of time. This is partly due to the fact that reporting requirements were much stricter and more comprehensive than in most other systems. For instance, the curve of U.S. experience, as compiled by the National Fire Protection Association, is based on insurance company, fire department, and press reports, and is generally deficient in reporting fires in which little or no damage resulted.

The DOE experience, while limited in number of incidents does cover a large variety of occupancies over a long period of time and includes many cases where one or two sprinklers operated and extinguished the fire with negligible damage. Thus, if a reporting system included all sprinkler operations the resulting experience would approximate the Australian New Zealand experience, namely that from one-half to two thirds of all fires in sprinklered properties are controlled or extinguished by the operation of a single sprinkler head. Correspondingly, the average loss in all sprinkler fires is undoubtedly much less than the averages reported by agencies that do not collect the minor-loss experiences.

VIII. FIRE PROTECTION WATER SUPPLY TESTING

The performance and reliability of water supplies for fire protection service must be determined by waterflow tests. If deficiencies in supply are disclosed, the causes are to be determined and improvements made or recommended. Testing procedures and associated calculations are based on application of fundamental principles pertaining to the flow of water through pipes and to the discharge from circular orifices. Results accurate to within five to ten percent may be expected.

Objective

To determine the ability of water distribution systems to supply a fire water demand requirement by conducting waterflow tests. Determination of water supply for fire protection purposes by other means such as computer analysis is not acceptable. Computer models may be used to determine expected flows and pressure.

Method

The method of testing is to discharge a measured quantity of water through openings of known size from a water distribution system, elevated tanks and fire pumps and to measure the flowing, residual, and static pressures on the piping system.

Water test procedures are given in NFPA codes and Factory Mutual Loss Prevention Data Sheets. A waterflow test following these procedures will establish a convenient system for complete analysis of the fire protection water system on a continuing basis.

Quantity of Water Flowed

Obtain a rate of waterflow that approximates the probable fire water demand for any credible fire which may be expected in the area.

Analysis

Results of flow tests will determine the performance characteristics of a water distribution system, elevated tanks, and fire pumps. In evaluating the adequacy of a water supply system, it is also necessary to determine the fire flow demands at multiple important locations throughout the distribution system.

Records

Records of waterflow tests should be considered an analysis of the adequacy or ability of the water distribution system to deliver the estimated fire flow

demand requirements of the facility or plant. Waterflow tests should be compared to those taken in former years to identify significant changes in performance and retained as permanent records.

The basic sample of the following page illustrates minimum data required for a waterflow test record. Each site may develop their own record form as special needs dictate.

Test Schedules

Hydrant flow tests shall be conducted yearly as determined by site fire protection engineers to assure the performance and reliability of fire water supplies.

Environmental Protection and Fire Protection Quality Assurance

All personnel conducting water supply tests shall coordinate water discharges with applicable environmental authorities. Water supply testing assures the quality and reliability of the fire protection system and should not be precluded by environmental concerns unless a formal exemption request is approved from the specified testing requirements.

A major fire event that is unmitigated because of unreliable fire protection water supplies will most likely result in greater environmental harm and consequences than the periodic controlled water discharges that ensures system reliability and quality.

HOW TO CONDUCT A WATER TEST

The simplest test requires only two locations -i.e., a Pressure (residual) Hydrant and a Flow Hydrant from the same underground main.

For correct results, proceed in this order:

1. Choose the Pressure (residual) Hydrant and remove one of its caps. Then attach the pressure gauge to this open butt. The petcock bleeder should be in the open position.

2. Open the hydrant several turns. This permits the trapped air to escape through the petcock bleeder. When water appears and all air has been exhausted, the petcock can be closed. Open the hydrant fully with a slow, firm, uniform motion.

3. The gauge on the Pressure (residual) Hydrant now indicates the static pressure. Record the static pressure.

4. Remove a cap from the 4 1/2-inch outlet of the Flow Hydrant (smaller hydrant outlets can be used if an adequate pressure drop can be achieved). Check beforehand to see that the stream will not tear up roadways or lawns or damage or flood property. A pegged tarpaulin or hydrant diffuser can be used to protect lawns.

5. Open the Flow Hydrant fully and let the stream stabilize for approximately 10 seconds. Read the Pressure Hydrant residual pressure and record. Measure the flowing stream's pressure with the pitot tube by inserting at the center of the stream, with the blade held a distance of half the diameter of the opening from the end of the hydrant butt. Record the flowing pressure.

   To achieve acceptable results, the residual pressure should indicate at least a 10 psi drop from the static pressure. An effort should be made to not drop the residual pressure below 20 psi.

NOTE: 1. Use flow tables consistent with those used the previous year, i.e., F.M. - N. F. P. A.

2. A nearby sprinkler riser gauge may be used in lieu of a second hydrant.

OAK RIDGE NATIONAL LABORATORY

WATER FLOW TEST RECORD

FOR DISTRIBUTION SYSTEM

Post _____ Test No. _____ Date _____

SKETCH OF LOCATION

Location of Resid. HYD _____

Area _____ Prev. Yrs. Flow _____ Gpm at _____ P.S.I. Static _____ P.S.I.

Observers _____

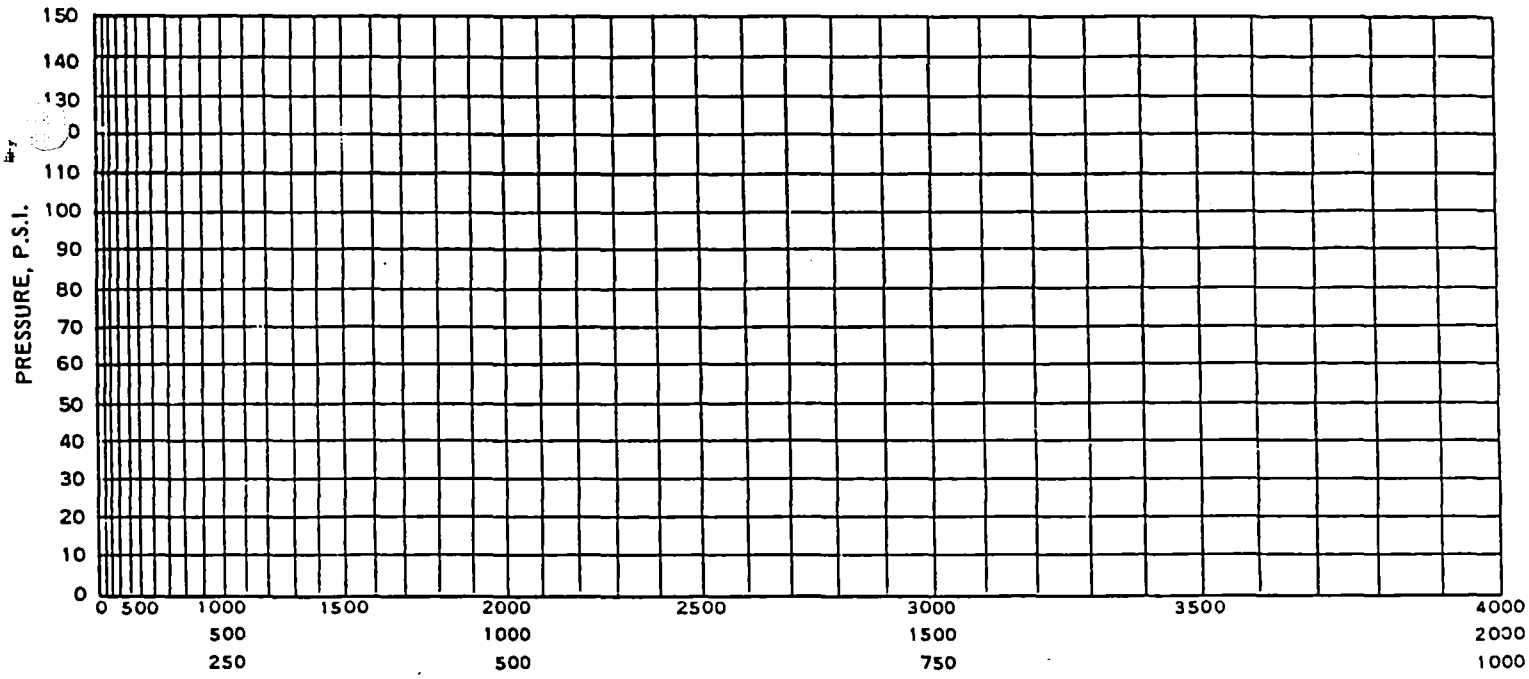
HYDRANT GAGE READINGS

	Pressures P.S.I.
Hydrants Closed (Static)	
Hydrants Open (Residual)	

HYDRANT DISCHARGE DATA

HYD'T NO.	OUTLET DIAMETER INCHES	PITOT PRESSURES, P.S.I.	DISCHARGE gpm
1.			
2.			
3.			
4.			

TOTAL DISCHARGE _____ gpm



SUMMARY AND RESULTS

Static Pressure _____ p.s.i.

Residual Pressures _____ p.s.i.

Total Discharge During Test _____ gpm

Remarks — State which flow table used. eg. F.M., I. R. I., N.F.P.A. etc.

NOTES ON SUPPLY:

Encl 1

IX. FIRE PUMP TESTING

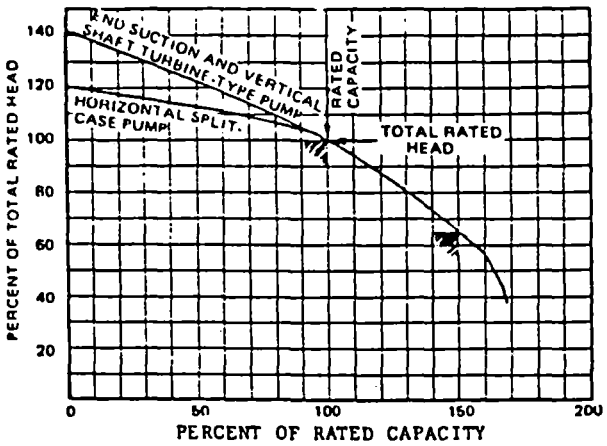
Inspection and Tests

At least once a month, the prime movers and pumps should be tested in accordance with recommendations outlined in Factory Mutual Data Sheet 3-7N, Centrifugal Fire Pumps. A record should be kept of the date, unusual conditions and other pertinent data as applicable.

Full flowing tests at 100% and 150% of rated capacity should be conducted annually.

Rating

The standard performance characteristics of a fire pump can be illustrated by a curve in which the volume of water discharged is plotted against the pressure developed by the pump.



Pumps are rated by a combination of three factors: discharge volume, net pressure and speed. The ratings are taken at a point about mid-way on the curve; for example, a pump may be designated at "1000 gpm at 100 psi.

According to the standard performance specifications, shut-off pressure at point A should not exceed 120% of the rated pressure (140% for vertical turbine pumps). Further, the pump must be able to deliver 150% of the rated volume at 65% of the rated pressure (point C).

Rated capacities of standard fire pumps range from 500 to 4500 gpm. These fire pumps have a rated pressure of 100 psi or more. Pumps installed in booster applications have a rated pressure of 40 psi or more and are also available with a capacity of 250 gpm.

Fire Pump Reliability

The following table compares pump failure rates of 1500 automatic starting fire pumps from tests witnessed by Factory Mutual field engineers.

	Number Tested	Number of Failures	Percent of Failures
Electric	1164	74	6.36%
Gasoline	149	27	18.12%
Diesel	153	13	8.50%
Steam	22	2	9.09%
Other	12	2	16.67%

Many of the failures that occurred in the automatic-starting controls were due to lack of maintenance, such as dirty contacts, faulty pressure switches, short circuits and burned-out parts, and pressure switches set too low. Some automatic pumps did not operate because pressure switches actuating the pumps were in the wrong location on the sprinkler system and were not immediately actuated by drop in pressure from sprinkler or hose line operation. Several gasoline-engine-driven pumps would not start because of faulty carburetor or choke adjustment.

Other difficulties encountered were inadequate suction supply, maintenance needed by pump driver, pump defects, foreign material in the pumps, dead batteries, faulty starters, clogged cooling systems, and faulty fuel pump operation. The time to discover and correct defects is during the monthly inspection. The sample formats can be used for recording and analyzing fire pump waterflow tests.

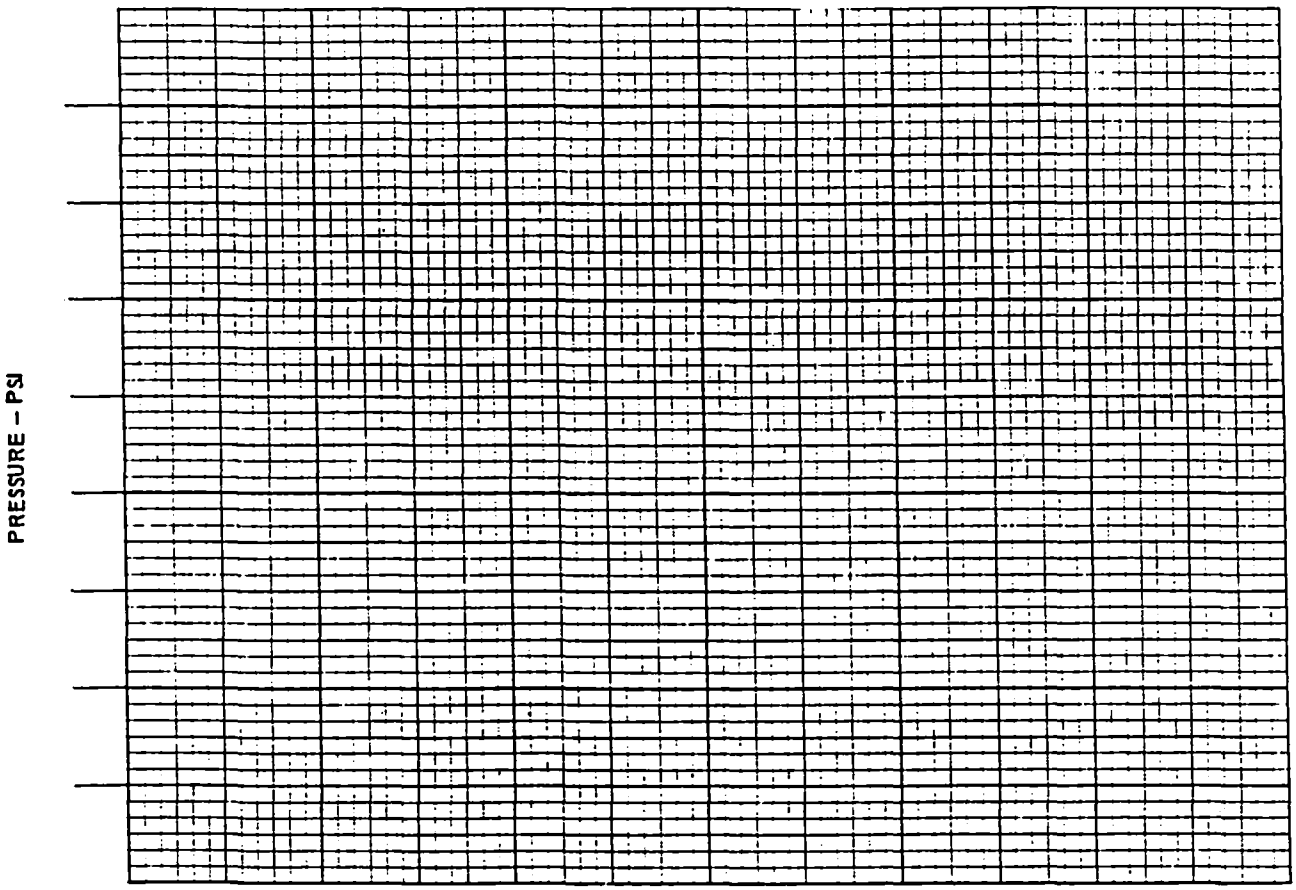
When comparing acceptance test results with the manufacturers curve, it will be necessary to correct the results to the rated speed of the pump. (See Appendix A of NFPA No. 20.)

FIXED FIRE PUMP TEST

TE	LOCATION	BY
MP NO.	TYPE TEST	MANUFACTURER
.UFACTURER'S MODEL	SERIAL NO.	YEAR BUILT
PUMP DRIVER ENGINE OR MOTOR	MAKE AND MODEL	BHP AT RPM
PUMP	MAKE AND MODEL	RATED CAPACITY GPM AT RPM
RATIO	PUMP TO ENGINE OR MOTOR	

:ST - LAYOUT OF HOSE	NOZZLE	NOZZLE	NOZZLE
	NOZZLE	NOZZLE	NOZZLE

TEST NO.	FLOW (GPM)	SUCTION (PSI)	DISCHARGE PRESSURES (PSI)	NET PRESSURES (PSI)	ELECTRIC MOTOR	
					AMPS	VOLTS
1						
2						
3						
4						



SUMMARY AND RESULTS

'T-OFF PRESSURE PSI	PRESSURE AT 100% RATED FLOW PSI	PRESSURE AT 150% RATED FLOW

EMARKS - (CONDITION OF PUMP)	NOTES

FREQUENCY OF TESTS OF INTERNAL COMBUSTION-ENGINE CONTROL FEATURES AND ALARMS AT ORO FACILITIES

RECOMMENDED TEST/FREQUENCY	FREQUENCY
1. Engine Start by Drop in Pressure or tank level	Quarterly
The actual water pressure switch should be tested to make sure it is operating and correctly adjusted. This should be accomplished by using bleed valve at the panel or by reducing the system or pressure elsewhere.	
2. Cooling Water Solenoid	Monthly
The flow rate of water discharging from the engine cooling systems should be observed to check operation of the valve and strainers. Depending upon water conditions, strainers may have to be cleaned weekly.	
3. Alarm Annunciation	Monthly
Running and trouble alarms remotely annunciated should be verified during each test or exercise.	
4. Lubrication solenoid (Vertical Turbine Pumps)	Monthly
Used on oil-lubricated shaft-bearings. The dripping action in the sight glass should be observed to verify proper operation.	
5. Low Lubricating Oil Pressure Alarm	Monthly
With the engine running, the lubricating oil pressure alarm circuit should be tested by jumpering the wire terminals on the switch.	
NOTE: This tests the circuit but not the switch itself. Some engine controllers are so wired that the trouble lamp will light momentarily each time the engine is started. This is an automatic test of the switch and should be observed each time the pump is started.	
If this feature has not been provided, the normally closed position of the pressure switch contacts should be verified annually while the engine is not running by using either an ohmmeter or a test light. (Voltage of the test light should not exceed that of the engine battery.)	

RECOMMENDED TEST/FRQUENCY	FREQUENCY
6. High Engine Temperature Alarm Tested by jumpering wire terminals on the temperature switch. Once again this step tests the circuit, not the switch. NOTE: Once a year, the temperature SWITCH should be tested by the utility or others according to the engine manufacture's recommendations. The proper method of testing the switch is to remove it from the engine and place it in fluid heated until the switch activates. Switching may be detected by measuring resistance across the contacts.	Semi-annual
7. Overspeed Shutdown Position Alarm If an air-damper-position supervisory switch has been provided, the overspeed alarm (when tested in Item 8) should continue to operate until the air damper is reset. If a solenoid fuel valve is the means for shutdown, the overspeed switch, which activates the solenoid, should be of the manual reset type and the overspeed alarm should continue to operate until reset. NOTE: Manual operation of the air damper should operate the alarm only not the "shutdown" circuit of the controller.	Semi-annual
8. Overspeed Shutdown With the pump operating at or near "shutoff" condition, the discharge valve to the system shut, and if the anticipated pressure increase will not be dangerously high, the engine-overspeed-shutdown device should be operated by manually overriding (slowly and partially) the normal speed governor. The engine should shutdown at approximately 120% of rated RPMs and operate the alarm. If it is not possible to over speed the engine and a solenoid operated air damper is used as the overspeed shutdown device, a jumper should be placed across the normally open contacts on the overspeed switching which actuates the air-damper solenoid. If a mechanically operated air damper is used, the damper may be operated by hand to check its mechanical features. If an energized-to-operate solenoid fuel-valve is the means for the overspeed, no special testing of the solenoid fuel-valve is necessary since it is tested each time the engine is run.	Annual

RECOMMENDED TEST/FREQUENCY	FREQUENCY
9. Ratchet Relay Action	Monthly
The engine should be started twice under automatic control to check the ratchet relay which alternately starts the engine on one battery and then on the other. This check can be made by observing the "lift" action of the manually operated battery contractors (older units) or connecting a voltmeter (2 required) to the contractors to monitor the switching of batteries.	
10. Failure-to-Start Alarm*	Annual
The failure-to-start alarm or the attempt-to-start cycle should be tested by disconnecting a wire at the controller terminal bar (usually Terminal #1). For diesel engines this disconnects the circuit for the fuel control solenoids. With a General Motors diesel or others of similar design, the wire at the fuelrack should also be disconnected. * An alternate to this is to disconnect the starter cable.	
11. Controller in "OFF POSITION" Alarm	Monthly
This should be checked or observed during monthly surveillance testing.	
12. Battery Failure Lockout Circuit	Annual
This test requires a cable be disconnected from one battery. Therefore, to avoid the possibility of a charging current spark igniting any hydrogen near battery vents, the following should be completed: A - Turn the controller switch to "OFF." B - Open the AC circuit to the charger at a convenient point. C - Disconnect cable from one battery. D - Restore AC power. E - Restore the panel to "AUTOMATIC." F - Operate the reset push-button for the disconnected battery. Two attempts should be made to start the engine. The engine should start both times with a other battery. The battery failure alarm for the disconnected battery should annunciate on the first attempt to start on that battery. After repeating steps A - F above, reconnect the battery cable and repeat entire procedure again for the second battery.	

RECOMMENDED TEST/FREQUENCY	FREQUENCY
13. Battery Failure Alarm NOTE: THIS FEATURE IS TESTED AUTOMATICALLY IN ITEM 11 ABOVE. The alarm for battery failure should be tested by opening, one at a time, the DC circuit breakers in the controller. This should de-energize a time-delay relay to reverse the "on" or "off" condition of the corresponding battery lamp and operate the alarm. The controller reset push-button be pressed to reset the relay.	Semi-annual
14. Manual Actuation at the Controller The engine should be started twice with a manual push-button, testing both sets of batteries. NOTE: THE NEXT SEVERAL TESTS ARE OPTIONS AVAILABLE ON SOME CONTROLLERS. IF APPLICABLE, SURVEILLANCE/TESTING PROGRAMS SHOULD INCORPORATE THE STEPS INTO PLANT PROCEDURES TO INSURE TOTAL RELIABILITY IN THE PUMP INSTALLATION.	Monthly
15. Manual Remote Actuation Manual remote starting circuits should be tested semi-annually. Improper operation should not prevent local control of the engine controller. Circuitry should be supervised.	Semi-annual
16. Automatic Start by Remote Equipment Control The associated circuitry to the electrical contacts of the automatic remote starting equipment (waterflow, deluge, preaction, etc.) should be tested annually by the actual operation of the switch to which the circuit is attached.	Annual
17. Automatic Engine Start Upon Loss of Power This should be tested by opening the AC circuit to the controller at any convenient location.	Quarterly
18. Weekly Program Timer If provided, the operation of the timer should be observed by plant personnel. Under no circumstances should the engine/controller be left unattended.	Monthly
19. Running Timer The timer should be observed monthly for proper setting (30 minutes). If a monthly program timer is not provided, the run time should be checked concurrently with the monthly tests.	Monthly

RECOMMENDED TEST/FREQUENCY	FREQUENCY
20. Sequential Starting For Multiple Pumps The adjustable time delay should be checked for proper functioning and timing (10 - 15 seconds). Failure of the preceding pump should not prevent a subsequent pump from starting.	Semi-annual
21. Pump Room Alarms NFPA 20 allows additional alarms to be provided in the controller to monitor various pump room conditions. Specifically, these may include: Pump Room Temperature, Low Reservoir, Low Suction Pressure, Relief Valve Open, Flow Meter On. These alarms should reset automatically.	Semi-annual
22. Low Fuel Level A visual and audible alarm should be received when the fuel level in the tank drops to 80% (or as specified). System Failure Alarm should annunciate remotely as well.	Quarterly

X. INSPECTION, TESTING, AND MAINTENANCE SUMMARY

Enclosed are the recommended frequencies for periodic inspection, test, and maintenance of fire protection equipment and related systems at Oak Ridge Operations Office facilities. Frequencies listed within this guide are intended to fully meet OSHA requirements and the intent of NFPA standards.

Proper inspection, testing, and maintenance (IT&M) of fire protection equipment is second in importance only to the provision of an adequately designed and installed system in reducing the potential for major damage due to fire. Protective and detection systems must stand idle for long periods of time yet must function properly and immediately at the time of an emergency. Thorough and periodic inspection, test, and maintenance of fire protection equipment will help make certain that such equipment is ready and able to function as designed.

Program Requirements:

* A training program shall be implemented for training of personnel assigned inspection, testing, and maintenance activities. Only trained personnel shall be assigned inspection, testing, or maintenance duties.

* Using a graded approach, a formalized maintenance/QA program for all fire protection systems shall be written in accordance with applicable DOE Orders, Rules, and guides.

* Maintenance history and trending program for deficiencies or failures shall be maintained to identify problems, document data, provide historical information for maintenance planning, and support the inspection, testing, and maintenance frequencies.

* All sites shall conduct self-assessments of the inspection, test, and maintenance program every 5 years.

* A person with appropriate training and qualifications shall be appointed to monitor and supervise the inspection, testing, and maintenance programs.

* The frequencies should be regarded as a minimum and specific vital, high risk (category 1), high value facilities or other conditions may warrant increased surveillance schedules. For example, those fire protection systems designated as "safety systems" under other DOE requirements should be inspected, tested, and maintained in full compliance with NFPA codes and standards.

* Oak Ridge Operations shall be notified of all impairments in accordance with the reporting requirements identified elsewhere within these guides.

* When a Life Safety Code required automatic sprinkler system is out of service for more than four hours within a 24-hour period, the

building shall be evacuated, or an approved fire watch shall be provided for all portions left unprotected by the sprinkler system shutdown until the system has been returned to service.

* Functional testing and maintenance activities should be conducted as recommended by the OSHA, manufacturer instructions, NFPA Codes or standards, and written site operating procedures. The flow down of requirements shall be clear and concise.

Justification for ORO Inspection, Testing, and Maintenance Frequencies:

* It is estimated that Oak Ridge Operations Office facilities average one fire per year that results in the discharge of an automatic sprinkler system. There is no record that an automatic sprinkler system has failed to operate during a fire event in the past 30 or more years of operations.

* Experience indicates that the failures of automatic sprinkler and alarm systems discovered in the course of the inspection and testing programs are random.

* All major sites employ professional fire protection engineering and fire department personnel who maintain continuous surveillance over the fire protection systems.

* Major sites provide electrical supervision of fire protection systems that are monitored at continuously attended location(s).

* Operating procedures, quality control/assurance programs, formalized reporting systems, written impairment control procedures, design review and approval processes, self-assessments, and other administrative control activities are well developed within the fire protection organizations.

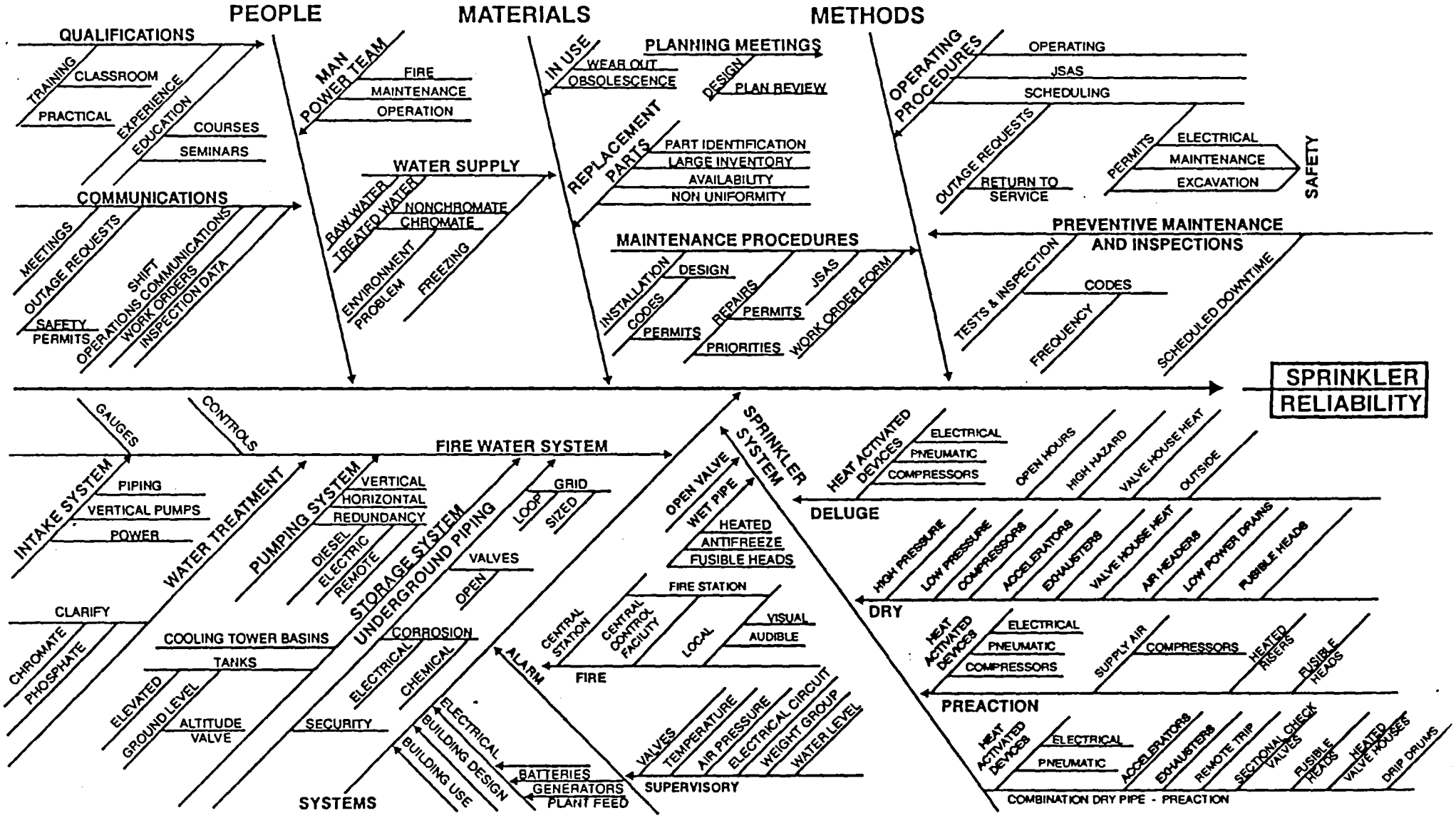
* Oversight of the inspection, test, and maintenance programs are being continuously reviewed by the DOE Field Office, outside independent assessments, and internal self-assessments.

* There are approximately 2500 sprinkler systems within the Oak Ridge Operations Field Office sites. Full compliance with the provisions of the NFPA standard would require approximately 60 additional personnel. Assuming a cost of $50,000 per year for salary and benefits, the total yearly additional cost of compliance would be $3 million per year. The cost-benefit of providing these additional resources does not appear prudent.

* The reduced frequency for testing and maintenance will enhance protection of the environment by reducing the amount of water discharges containing chlorine or other additives.

* The Oak Ridge Operations Field Office inspection, testing, and maintenance policies have been in affect for several years and the fire loss record has been outstanding for a sustained period.

SPRINKLER RELIABILITY



MAINTENANCE MANAGEMENT/QUALITY ASSURANCE PLAN

FIXED FIRE PROTECTION SYSTEMS

The maintenance program shall contain provisions sufficient to ensure the operability and reliability of the fixed fire protection systems. A maintenance plan should be prepared for each site and keep current for the biannual field office appraisals.

1. A maintenance plan should clearly define the following:
   a. The systems and components that comprise the fixed fire protection systems.
   b. The requirements of the maintenance program that are derived from NFPA and DOE requirements.
   c. The management systems used to control those activities including the means for trending and monitoring the reliability, system operability and maintenance backlog.
   d. The assignment of responsibility and authority for all levels of the test, inspection, and maintenance organizations.
   e. Provisions for identification and evaluation of system problems, impairments, compensatory actions and reporting.
   f. Performance indicators and acceptability criteria that is utilized to measure system operability
   g. Interfaces between maintenance and other organizations.

2. <u>A maintenance program shall address each of the following elements:</u>

a. Organization and administration

b. Maintenance training and qualifications

c. Maintenance facilities, equipment, and tools

d. Types of inspection, testing and maintenance

e. Maintenance procedures and other related documents

f. Planning, scheduling, and coordination of the activities

g. Acceptance testing and preoperational review of modifications

h. Procurement of parts, materials, and services

i. Material receipt, inspection storage and retrieving

j. Control and calibration of test equipment

k. Maintenance tools and equipment

l. Facility condition self-assessments.

m. Management interfaces with facility operations

n. Maintenance history and trending

o. Configuration controls

p. Record keeping and occurrence reporting

q. Inspection forms

r. Workload analysis

s. Inspection, testing, and maintenance frequencies

t. Compliance with DOE standards

u. Impairment controls and compensatory actions

References

1. DOE Order 4330.4B, "Maintenance Management Program."

2. DOE-STD-1051-93, "Guideline to Good Practices for Maintenance Organization and Administration at DOE Nuclear Facilities."

3. DOE-STD-1050-93, "Guideline to Good Practices for Planning, Scheduling, and Coordination of Maintenance at DOE Nuclear Facilities."

4. DOE-STD-1052-93, "Guideline to Good Practices for Types of Maintenance Activities at DOE Nuclear Facilities."

5. DOE-STD-1053-93, "Guideline to Good Practice for Control of Maintenance Activities at DOE Nuclear Facilities."

6. 10 CFR Part 30, "Nuclear Safety Management."

INSPECTION, TEST, AND MAINTENANCE FREQUENCIES - ORO[1]

Notes:

(1) The frequencies specified in NFPA 25 should be followed for Category I nuclear facilities or facilities specifically open to the general public, i.e., museums and public auditoriums.

(2) Failure occurring during surveillance testing shall be trended and, where applicable, reported in accordance with unusual occurrence procedures and reporting requirements listed elsewhere in this guide.[2]

(3) It is not the intent of this guideline to cover all aspects of inspection and testing. It is generic in nature and specific applications, equipment, conditions, or facilities may warrant increased and/or decreased surveillance schedules.

ITEM	NFPA 25 1995 ED.	NFPA 25 FREQUENCY	DOE FREQUENCY	ORO FREQUENCY	JUSTIFICATION
Chapter 2, Sprinkler Systems					
Sprinkler head, Inspection	2-2.1.1	Annually	Annually not to exceed 3 years	At the same frequency as facility assessments, not to exceed 3 years.	Sprinkler systems are reviewed by qualified engineers during scheduled self-assessments.
Spare Sprinkler head, Inspection	2-2.1.3	Monthly	Annually	Annually	If a stock of spare sprinklers are kept at a central location this is not needed.
Alarm Device, Inspections	2-2.6	Monthly	Quarterly	Quarterly	Consistent with NFPA 72.

ITEM	NFPA 25 1995 ED.	NFPA 25 FREQUENCY	DOE FREQUENCY	ORO FREQUENCY	JUSTIFICATION
Hydraulic nameplate on sprinkler systems, Inspection	2-2.7	Quarterly	Annually not to exceed 3 years.	At the same frequency as facility assessments, not to exceed 3 years.	Contractors maintain a system of drawings, calculations, and other documentation that verify hydraulic design requirements.
Water-flow alarms, Test	2-3.3	Quarterly	Quarterly	Semiannual	ORO failure rates over a period of approximately 50 years do not justify more frequent testing or the costs that would be incurred. Less frequent testing will also minimize discharges to the environment.
Gauges, Test	2-3.2	5 years	When abnormal	When abnormal	System gauges are not used to validate system operability.
Sprinkler System Piping, Inspection	2-2.2	Annually	Annually not to exceed 3 years	At the same frequency as facility assessments, not to exceed 3 years.	Sprinkler systems are reviewed by qualified fire protection engineers during scheduled self-assessments.
Water motor gong, Test	2-3.3	Quarterly	Quarterly	Semiannual	Failure rates do not justify more frequent testing or the costs that would be incurred.
Compressor, Maintenance	2-4.2.2	Per mfg.	Annually	Annually	Annual maintenance is reasonable.

ITEM	NFPA 25 1995 ED.	NFPA 25 FREQUENCY	DOE FREQUENCY	ORO FREQUENCY	JUSTIFICATION
Chapter 3, Standpipe and Hose Systems					
Hose Cabinets, Inspection	Table 3-1	Annual	Annual not to exceed 3 years.	At the same frequency as facility assessment, not to exceed 3 years.	Hose cabinets are not subject to failure which would impair fire fighting ability.
Alarm Devices, Test	Table 3-1	Quarterly	Quarterly	Semiannual	Failure rates do not justify more frequent testing or the costs that would be incurred.
Hose Nozzles, Inspection	Table 3-1 refers user to NFPA 1962.	Annually by NFPA 1962. Monthly by para.3-2.1 of NFPA 25.	At same freq. as facility assessments, not to exceed 3 years.	none	This requirement was taken out of the NFPA 25, 1994 Edition. Nozzles are rugged devices and not subject to inordinate failures.
Hose Nozzles, Test	Table 3-1,	Annually	When abnormal	When abnormal	Test when visual inspection reveals an abnormality or after nozzle maintenance.
Hose storage rack, Inspection	Table 3-1, ref: NFPA 1962.	Annual	Annual not to exceed 3 years	At same frequency as facility assessments, not to exceed 3 years.	These are not subject to inordinate failure and will be reviewed during scheduled self-assessments.

ITEM	NFPA 25 1995 ED.	NFPA 25 FREQUENCY	DOE FREQUENCY	ORO FREQUENCY	JUSTIFICATION
Hose storage rack, Test	Table 3-1, ref: NFPA 1962.	Annual	Annual not to exceed 3 years	When abnormal	Test when visual inspection notes an abnormality or after maintenance. Storage racks not subject to failure without apparent damage.
Standpipe, Flow and hydrostatic test	Table 3-1	5 years		5 years	Flow tests and hydrostatic tests should be performed to ensure operability.
Standpipe systems, Alarm device, Test	Table 3-1	Quarterly	Quarterly	Semiannual	Failure rates and the costs incurred do not justify a greater frequency rate.
Chapter 4, Private Fire Service Mains					
Mainline Strainers, Inspection	4-4.2	Annually	Per Mfg. or annually	Per Mfg. or annually	Inspect per manufacturers requirements if used in a portable water system. Annual if used in a non-potable water system or per Mfg. instructions

ITEM	NFPA 25 1995 ED.	NFPA 25 FREQUENCY	DOE FREQUENCY	ORO FREQUENCY	JUSTIFICATION
Hydrants, Dry Wall & Wet, Inspection, Test, & Maintenance	4-4.3	I - 6 mo. T - 1 yr M - 1 yr	Annually	Annually	Combined Inspection (I), Test (T), and Maintenance (M). Ensure that valve to hydrant is fully open. Each hydrant shall be opened fully and water flowed for not less than 1 minute or until foreign material has cleared. Hydrant drainage shall be verified. (tests shall be coordinates with environmental authorities).
Underground piping flow tests	4-3.1	minimum 5-year intervals		Annual (Adequate water supplies are a vital fire protection element.)	Flow tests representative of those expected during a fire should be performed annually at selected plant areas and compared to previous years. Different areas of a facility should be tested on a 5-year cycle to ensure that all areas are capable of achieving required flow demands.
Hose/Hydrant Houses, Inspection	Table 4-2.1	Quarterly	Annually	Annually	Hydrant/hose houses are not subject to frequent failures.

ITEM	NFPA 25 1995 ED.	NFPA 25 FREQUENCY	DOE FREQUENCY	ORO FREQUENCY	JUSTIFICATION
Chapter 5, Fire Pumps					
Fire pumps Heating system, Inspection	Table 5-1.1	Weekly during heating season	Weekly or Monthly	Weekly or Monthly	Weekly unless the pump room is constantly monitored for low temperature conditions.
Fire pumps, Vent louvers, Inspection	Table 5-1.1	Weekly during heating season	Weekly or Monthly	Weekly or Monthly	Weekly unless the pump room is constantly monitored for low temperature conditions.
Chapter 6, Water Storage Tanks					
Water storage tanks, Water condition (check for ice buildup), Inspection	6-2.9	Daily/ weekly during the heating season	Daily during heating season unless monitored	Daily when temp. is <32°F unless monitored	Daily when the temperature drops below freezing unless the water temperature is constantly monitored.
Water level	6-2.1	monthly/ quarterly if monitored		Quarterly	Fire water storage tanks should be inspected quarterly by overflowing, except where tank levels can be visually verified.
Interior inspection	6-2.4	5 years		5 years	Tank interiors and corrosion protection should be inspected every 5 years.

ITEM	NFPA 25 1995 ED.	NFPA 25 FREQUENCY	DOE FREQUENCY	ORO FREQUENCY	JUSTIFICATION
Water storage tanks, Heating system, Inspection	6-2.8	Daily/ weekly during the heating season	Daily during heating season unless monitored	Daily when temp. is <30°F unless monitored	Daily when the temperature drops below freezing unless the water temperature is constantly monitored.
Chapter 7, Water Spray Fixed Systems					
Mainline strainers, Inspection and Maintenance, if required	7-3.9	I - per mfg. M - 5 years	5 years combined I & M	5 years combined I & M	Use engineering judgement to set an inspection frequency if water is contaminated.
Valve Enclosures, cold weather, Inspection	7-3.1.2	Daily/ Weekly	See freq. for chap. 2,5, &9	weekly or Monthly if monitored	Inspect monthly if valve enclosures are monitored by a supervised low temperature alarm device.
Pipe & hangars, Inspection	7-3.4.1 & 7-3.4.2	Quarterly	Annually	Annually	Inspect during the annual flow test.
Spray nozzles, Inspection	7-3.5	Annually	Annually	Annually	Inspect during the annual flow test.
Individual Nozzle strainers, water spray & foam systems, Inspection & Maintenance	7-3.5	Annually	Annually	Annually	Inspect during the annual flow test.

ITEM	NFPA 25 1995 ED.	NFPA 25 FREQUENCY	DOE FREQUENCY	ORO FREQUENCY	JUSTIFICATION
Drainage, Inspection	7-3.10	Quarterly	Annually	Annually	Inspect during the annual flow test.
Chapter 8, Foam-Water Sprinkler Systems					
Foam-water systems Discharge device location, position, and check for obstruction, Inspection	Table 8-2	Monthly/ Annually	Annually	Annually	Inspect during he annual test.
Foam-water systems, Foam concentrate strainer, Inspection	8-2.9	After each flow test or operation	Annually	Annually	Inspect during the annual test.
Foam-water systems Drainage, Inspection	Table 8-2	Quarterly	Annually	Annually	Inspect during the annual test.

ITEM	NFPA 25 1995 ED.	NFPA 25 FREQUENCY	DOE FREQUENCY	ORO FREQUENCY	JUSTIFICATION
Foam-water systems, Proportioning systems, Inspection	Table 8-2	Monthly	Monthly or Annually	Monthly or Annually	Configuration - a. Annual for fixed proportioners. b. Monthly for adjustable proportioners. c. Fluid level - Monthly d. Power systems' strainers - Monthly
Foam-water systems, Foam concentrate pump power, Inspection	Table 8-2	See section 5. Weekly/ Annually	Monthly	Monthly	Power failures are a common failure mode.
Foam-water systems, Foam concentrate pump running, Maintenance	Table 8-2	See section 5. Weekly/ Annually	Monthly	Monthly	Power failures are a common foam system failure mode.
Foam-water systems Foam concentrate strainer, Inspection & Maintenance	8-2.9	Annually	Annually	Annually	Annually after each flow test.
Pipe corrosion, Inspection	Table 8-2	Quarterly	Annually	Annually	Inspect during annual test.
Pipe damage, Inspection	Table 8-2	Quarterly	Annually	Annually	Inspect during annual test.

ITEM	NFPA 25 1995 ED.	NFPA 25 FREQUENCY	DOE FREQUENCY	ORO FREQUENCY	JUSTIFICATION
Fittings corrosion, Inspection	Table 8-2	Quarterly	Annually	Annually	Inspect during annual test.
Fittings damage, Inspection	Table 8-2	Quarterly	Annually	Annually	Inspect during annual test.
Hangers & supports, Inspection	Table 8-2	Quarterly	Annually	Annually	Inspect during annual test.
Discharge device location, position, and obstruction, Test	Table 8-2	Annually	5 years	Annually	Inspect during annual test.
Foam concentrate strainers, Test	8-2.9	Annually	5 years	Annually	Verify during annual test.
Proportioning systems, all, Test	8-2.11	Annually	5 years	Annually	Foam systems are subject to corrosion and should be tested annually. All foam discharges should be minimized.
Complete foam-water systems, Operational Test	8-3.3	Annually	5 years	Annually	Foam systems should be tested annually to verify operability.

ITEM	NFPA 25 1995 ED.	NFPA 25 FREQUENCY	DOE FREQUENCY	ORO FREQUENCY	JUSTIFICATION
Chapter 9, Valves and FD Connections					
Alarm valves, Exterior Inspection	9-4.1.1	Monthly	Quarterly	Monthly or Quarterly	Inspect all unsupervised shutoff valves that are installed before the alarm pressure device monthly.
Hose connection, Inspection	9-5-2	Quarterly	Quarterly	Quarterly	Facilities are not accessible to the public and tampering is not experienced.
Fire Department connections, Inspection	9-7	Quarterly	Quarterly	Quarterly	Facilities are not accessible to the public and tampering is not experienced.
Main drain, Test	9-2.6	Quarterly	Quarterly	Semiannual	ORO failure rates over a period of 50 years do not justify more frequent testing or the costs that will be incurred. Less frequent testing will minimize discharges to the environment.
Dry pipe valves: Quick opening devices, Test	9-4.4	Quarterly	Six months	Annually	Quick opening devices are relatively simple and annual testings is adequate to detect and repair mechanical problems.
Preaction/deluge dry pipe valve, Inspection of exterior	9-4.3.1.3	Monthly	Quarterly	Quarterly	Facilities are not accessible to the public and tampering is not experienced.

ITEM	NFPA 25 1995 ED.	NFPA 25 FREQUENCY	DOE FREQUENCY	ORO FREQUENCY	JUSTIFICATION
Valve enclosure, Inspection	9-4.3.1	During cold weather: daily/ weekly if temperature constantly monitored	Daily, if no temp. monitoring Monthly, if monitored	Daily at temp. <32°F Monthly if low temp. alarm	Daily when temperatures are expected below freezing and valves are subject to freezing, i.e., not located in a heated building. Monthly if a supervised low temperature alarm is constantly monitored.
Dry pipe valve enclosure, Inspection	9-4.3.1	During cold weather: daily/ weekly if temperature constantly monitored	Annually	Daily at temp. <32°F Monthly if low temp. alarm	Daily when temperatures are expected below freezing. Monthly if a supervised low temperature alarm is constantly monitored.
Dry Pipe Valve's Interior, Inspection	9-4.4.1.4	Annually	Annually	Every 3 years at full flow test.	There is no evidence that annual interior inspection of valves is needed to ensure operability. Water supplies are relatively clean.
Orifices, filters, and strainers, Inspection	9-4.4.1.5	5 years	5 years	5 years	Operability of this equipment is verified during other testing.

ITEM	NFPA 25 1995 ED.	NFPA 25 FREQUENCY	DOE FREQUENCY	ORO FREQUENCY	JUSTIFICATION
Water-flow alarm, Test	9-2.7	Quarterly	Quarterly	Semiannual	ORO failure rates over a period of 50 years do not justify more frequent testing or the costs that will be incurred. Less frequent testing will minimize discharges to the environment.
Post Indicator Valves, position, Test	9-3.4.1	Quarterly	Semiannual	Semiannual	Test valve position during semiannual alarm test. Valve supervisory switches shall be tested.
Dry pipe valves: priming water, Test	9-4.4.2.1	Quarterly	Semiannual	Annual	Test priming water prior to cold weather. Loss of priming water may cause valves to trip but would not cause failure of the valve.
Dry pipe valves: low air pressure alarms, Test	9-4.4.2.6	Quarterly	Six months	Semiannual	Test during the alarm flow test.
Deluge/pre-action valves: priming water, Test	9-4.3.2.1	Quarterly	Six months	Annual	Test priming water prior to cold weather. Loss of priming water may cause valves to trip but would not cause failure of the valve.

ITEM	NFPA 25 1995 ED.	NFPA 25 FREQUENCY	DOE FREQUENCY	ORO FREQUENCY	JUSTIFICATION
Full trip test - Preaction/deluge firecycle	9-4.3.2.2	Annually		Annual	Trip tests of the systems shall be tested with the control valve fully open, not partly closed. Tests shall be conducted in accordance with the manufacturers instructions.
Full trip test - Dry pipe	9-4.3.2.2	Every 3 years		Every 3 years	Trip tests of the systems shall be tested with the control valve fully open, not partly closed. Tests shall be conducted in accordance with the manufacturers instructions.

1. The frequency notations, as used in this guide, should be defined as follows: (See DOE Order 5480.22)

Notation	Minimum Frequency
Daily	At lease once per 24 hours.
Weekly	At least once per 7 days
Monthly	At least once per 31 days
Quarterly	At least once per 92 days
Semiannually	At least once per 184 days

*The surveillance shall be performed within the specified interval, with a maximum extension of 25 percent of the interval between any two consecutive surveillance. (This extension is intended to

provide operational flexibility both for scheduling and for performing surveillance. It shall not be relied upon as a routine extension of the specified interval)

Failures to perform the surveillance within the required time intervals shall be documented and kept on file for the biannual fire protection appraisal. Systemic failures to meet surveillance schedules shall be evaluated and corrected.

2. The following criteria shall be used to determine and trend component failures:

	COMPONENT	REFERENCE	FAILURE CRITERIA
a.	Water flow alarm-Initiating Device	NFPA 72 section 5-7	Alarms shall be received at the constantly attended location within ~~90~~ seconds after the inspectors test valve is fully opened. 180 sec
b.	Wet pipe/dry pipe/ preaction/deluge valves	IRIformation IM.12.02	Operation of the value shall be considered unsatisfactory if: a. The valve fails to open b. A mechanical or operating failure of parts occurs. c. Water does not reach the test connection within one minute, measured from the time the inspector's test valve is fully open.
c.	Local alarm, i.e., electric bell or water motor gong	NFPA 13 section 8-2.4	Water-flow detecting devices shall result in an alarm within 5 minutes after the inspectors test valve is fully open.
d.	Firewater control valves		Valves that are found more than 5 turns closed shall be considered a failure and reported as an improper impairment.

FIRE ALARM SYSTEM Testing Frequencies		
NFPA 72 - TABLE 7-3.2		ORO GUIDANCE
DEVICES	FREQUENCY	FREQUENCY
1. Alarm Notification Applicances		Note 1
a. Audible Devices	Annual	Annual
b. Speakers	Annual	Annual
c. Visible Devices	Annual	Annual
2. Batteries - Central Station		
a. Lead Acid Type		
1. Charger Test	Annual	Annual
2. Discharge Test (30 minutes)	Monthly	Monthly
3. Load Voltage Test	Monthly	Monthly
4. Specific Gravity	Semiannual	Semiannual
b. Nickel-Cadmium Type		
1. Charger Test	Quarterly	Quarterly
2. Discharge Test (30 minutes)	Annual	Annual
3. Load Voltage Test	Annual	Annual
c. Sealed Lead Acid Test		
1. Charger Test	Monthly	Monthly
2. Discharge Test (30 minutes)	Monthly	Monthly
3. Load Voltage Test	Monthly	Monthly
3. Batteries - Fire Alarm Systems		
a. Lead-Acid Type		
1. Charger Test	Annual	Annual
2. Discharge Test	Semiannual	Semiannual
3. Load Voltage Test	Semiannual	Semiannual
4. Specific Gravity	Semiannual	Semiannual
b. Nickel-Cadmium Type		
1. Charger Test	Annual	Annual
2. Discharge Test	Annual	Annual
3. Load Voltage Test	Semiannual	Semiannual
c. Primary Type (Dry Cell)		
1. Load Voltage Test	Monthly	Monthly
d. Sealed Lead Acid Type		
1. Charger Type	Annual	Annual
2. Discharge Test	Annual	Annual
3. Load Voltage Test	Semiannual	Semiannual

4. Batteries - Public Fire Alarm Reporting System (Voltage Test in accordance with NFPA 72) a. Lead-Acid Type 1. Charger Type 2. Discharge Test (2 hours) 3. Load Voltage Test 4. Specific Gravity b. Nickel-Cadmium Type 1. Charger Test 2. Discharge Test (2 hours) 3. Load Voltage Test c. Sealed Lead-Acid Type 1. Charger Test 2. Discharge Test (2 hours) 3. Load Voltage Test	Daily Annually Quarterly Quarterly Semiannually Annual Annual Quarterly Annual Annual Quarterly	Not applicable At OR sites
5. Conductors/Metallic	Init./Reaccpt.	Init./Reaccpt.
6. Conductors/Nonmetallic	Init./Reaccpt.	Init./Reaccpt.
7. Control Equipment: Fire Alarm Systems Monitored for Alarm, Supervisory, Trouble Signals a. Functions b. Fuses c. Interfaced Equipment d. Lamps and LEDs e. Primary (Main) Power Supply f. Transponders	 Annual Annual Annual Annual Annual Annual	 Annual Annual Annual Annual Annual Annual
8. Control Equipment: Fire Alarm Systems Unmonitored for Alarm, Supervisory, Trouble Signals a. Functions b. Fuses c. Interfaced Equipment d. Lamps and LEDs e. Primary (Main) Power Supply f. Transponders	 Quarterly Quarterly Quarterly Quarterly Quarterly Quarterly	 Annual Annual Annual Annual Annual Annual
9. Control Unit Trouble Signals	Annual	Annual
10. Emergency Voice/Alarm Communications Equipment	Annual	Annual
11. Engine-Driven Generator	Weekly	Weekly
12. Fiber Optic Cable Power	Annual	Annual
13. Guard's Tour Equipment	Annual	Not Applicable

14. Initiating Devices		
a. Duct Detectors	Annual	Annual
b. electromechanical Releasing Device	Annual	Annual
c. Extinguishing System Switches	Annual	Annual
d. Fire-Gas and Other Detectors	Annual	Annual
e. Heat Detectors	Annual	Annual (20%)
f. Fire Alarm Boxes	Annual	Annual
g. Radiant Energy Fire Detectors	Annual	Annual
h. Smoke Detectors - Functional	Annual	Annual (20%)
i. Smoke Detectors - Sensitivity	See NFPA 72	Annual (20%)
j. Supervisory Signal Devices	Quarterly	Semiannual
k. Waterflow Devices	Quarterly	Semiannual
15. Interface Equipment	Annual	Annual
16. Off-Premises Transmission Equipment	Quarterly	Semiannual
17. Remote Annunciators	Annual	Annual
18. Retransmission Equipment	See NFPA 72	Not applicable
19. Special Hazard Equipment	Annual	Annual
20. Special Procedures	Annual	Annual
21. System and Receiving Equipment - Off -Premises		
a. Operational		
1. Functional - All	Annual	Annual
2. Transmitters - WF & Supervisory	Quarterly	Semiannual
3. Transmitters - All Others	Annual	Annual
4. Receivers	Monthly	Semiannual
b. Standby Loading - All Receivers	Monthly	Semiannual
c. Standby Power		
1. Receivers - All	Monthly	Semiannual
2. Transmitters - All	Annual	Semiannual
d. Telephone Line - All Receivers	Monthly	Semiannual
e. Telephone Line - All Transmitters	Annual	Semiannual

Notes:

1. Unsupervised alarm notification applicances are to be tested bimonthly in accordance with OSHA section 1910.165(d)(2).

MISCELLANEOUS EQUIPMENT Test, Inspection, and Maintenance Frequencies	
EQUIPMENT	**FREQUENCY**
1. Emergency Lighting & Internally Illuminated Exit Signs	
a. Visual during Building Inspections:	Monthly
b. Activate lights for a minimum of 30 seconds - Batteries or Generators:	Semiannual
c. Activate batteries for a minimum of 60 minutes:	Annual
d. Ensure transfer of power to lights - Generators:	Annual
2. Fire Doors	
a. Visual during monthly inspections:	Monthly
b. Operability Tests:	Annual
3. Fire Dampers	
Test & Inspect 20% on a 5 year cycle:	20% Annual
4. Dry Chemical Fire Extinguishing Systems	
a. Visual Inspection:	Monthly
b. Remote alarm Test:	Semiannual
C. Maintenance & Testing:	Annual
5.. Mobile Fire Apparatus	
a. Visual Inspection and tests:	Each Shift
b. Road Test:	Monthly
c. Pump Test:	Weekly
d. Flow Capacity:	Annual

MISCELLANEOUS EQUIPMENT Test, Inspection, and Maintenance Frequencies	
EQUIPMENT	**FREQUENCY**
6. Self-Contained Breathing Apparatus:	
a. Service Checks,	
Visual Inspection:	Weekly
Detailed Inspection:	Monthly
After each Use:	See NFPA 1404
b. Maintenance: (According to manufacturer's instructions and NFPA 1404)	Annual
c. Cylinder Test & Maintenance: (Hydrostatic test, internal and external inspection:	According to Mfg Instructions
d. Breathing Air: (Air quality check by a qualified laboratory)	Every 3 months
e. Program Review: (Review respiratory protection policies and procedures)	Annual

XI. MEMBRANE STRUCTURES - FIRE SAFETY GUIDE

1. **Scope.** This guide applies to membrane structures constructed for the purpose of storing contaminated waste and is intended to prescribe minimum fire safeguards so as to provide reasonable fire safety and compliance with DOE requirements.

2. **Occupancy classification.**

   2.1 Occupancy classification and construction of membrane structures should be determined under the provisions of the Uniform Building Code. Area limitations should be as determined under the Uniform Building Code.

   2.2 Membrane structures shall not be utilized for high hazard occupancies as classified under the Uniform Building Code (UBC). All combustible contents shall be contained in sealed metal or fire retardant storage containers acceptable to the authority having jurisdiction.

   Refer to section 4 for protection requirements.

   2.3 Offices, sheds, and trailers and other enclosures should be prohibited within membrane structures.

3. **Construction.**

   3.1 Approved tentage materials listed by Underwriters Laboratories, Inc. (UL) should be used in the construction of all membrane structures. UL identifies the test as UL 214, "Tests for Flame Propagation of Fabrics and Films." Material that meets the UL test is listed under the FABRICS (GPIX) category and is found in the UL Building Materials Directory.

   3.2 Any other fabrics or plastic sheeting used shall be certified by a recognized laboratory as conforming to the requirements of the Large-Scale Test contained in NFPA 701, "Standard Methods of Fire Test for Flame-Resistant Textiles and Films." Each thickness of a product is considered a unique material and as such will need separate fire testing. Adequate documentation showing that the product has passed this test should be retained by the fire protection "authority having jurisdiction" at each site.

   3.3 Multiple membrane structure "villages" should be laid out in accordance with a prescribed plan. Groups of membrane structures should be separated from each other by 30 foot wide fire breaks. In all cases, membrane structures should not be located within 50 feet of any permanent building, structure, or equipment (i.e., transformers). See DOE standard DOE/EV-0043 for applicable recommendations.

4. **Fire Protection.**

4.1 Protection of membrane structures should be in accordance with following table.

STORAGE CONDITIONS	PROTECTION REQUIRED
Noncombustible waste in metal containers.	Appropriate exits Fire extinguisher(s)
Combustible waste in metal containers.	Appropriate exits Fire extinguishers(s) Fire hydrant within 75 ft. Fire alarm box at entrance
Contaminated waste in combustible containers or overpacks.	Not permitted unless provided with automatic sprinkler protection and an alarm system and approved by the authority having jurisdiction.

Note: It is assumed that waste drums are stored on wood pallets, approved plastic, or metal pallets. No idle storage of combustible pallets should be permitted within membrane structures.

4-2 No portable heating devices should be used in membrane structures. Heat may be provided by forced air systems from outside the structure.

4-3 Exits should be arranged in accordance with OSHA provisions and the Life Safety Code under storage occupancies requirements.

4-4 There should be a minimum of one fire extinguisher suitable for all classes of fires located at the entrances to the membrane structure.

4-5 A fire hazard analysis should be performed during construction that verifies compliance with this guide. Fire engineering surveys should be performed annually to ensure continuing compliance.

XII. FIRE AND EMERGENCY OPERATIONS

POLICY

It is a fundamental policy of the DOE Order 5480.7A, Fire Protection, that redundant fire protection be provided by a plant fire department, and/or emergency squad, and/or mutual aid agreement sufficient to provide manual fire fighting capabilities in the absence or impairment of other fire protection systems.

OBJECTIVES

a. Structural fire fighting, rescue, and hazardous material response personnel shall be trained by "certified" instructors in accordance with applicable OSHA and National Fire Protection Association provisions and standards. Certification of instructors shall be provided by a recognized authority.

   All emergency response personnel shall be trained and educated commensurate with those duties and functions that they are expected to perform. Fire training and education shall be similar to that provided by recognized fire training schools. Site specific training such as radiation, criticality, hazardous materials, rescue, vehicle extrication, etc., shall be provided to cope with hazards and risks unique to each facility. Training requirements shall be determined by a detailed job task analysis.

b. The fire department and emergency squad shall maintain current pre-fire plans and conduct joint realistic drills adequate to cope with potential site incidents. Training shall include education and hands-on fire fighting exercises to ensure safe, effective, skilled, and confident teamwork.

c. A written safety program shall be established and maintained for fire fighting personnel that complies with the intent of NFPA 1500, "Fire fighter Health and Safety." Physical fitness programs should be provided on a voluntary basis.

d. The minimum response requiring interior fire fighting, or other operations requiring the entrance of SCBA-equipped people, shall be five properly trained persons. When less personnel are available, interior operations shall not be attempted. (Reference DOE Headquarters NFPA Implementation Plan dated September 29, 1988)

e. At major sites where radiation, criticality, or nuclear reactor risks are present, or emergency medical response is performed by the fire department, minimum response shall consist of an incident commander and tactical officer at the emergency scene. Incident commanders and fire officers shall be trained and certified in accordance with applicable NFPA codes, standards, and OSHA requirements.

Certification shall be based on accredited systems such as provided by the applicable recognized authorities.

f. Fire fighting equipment shall be provided in accordance with the requirements of OSHA and applicable NFPA codes. The wearing of protective equipment shall be strictly enforced.

g. Realistic drills shall be performed so that emergency response personnel can practice as a team.

Hands-on fire drills shall be performed at regular intervals not to exceed three months for each shift fire department and/or brigade member. Each member of the emergency response team should participate in each drill, but must participate in at least four drills per year. Written safety plans shall be prepared for each drill.

A sufficient number of drills, but not less than two for each shift per year, shall be unannounced to determine emergency response readiness. At least one drill per year shall be performed on a "back-shift" under night time conditions.

Drills shall be critiqued by qualified individuals including members of the plant management staff and a written report of each drill maintained three years for DOE review.

h. Individual training records shall be maintained for at least three years for DOE review.

i. Each major site shall maintain an Emergency Planning Committee, and the Fire Chief shall an active member of the committee. It is intended that those with direct emergency responsibility be given a lead role in planning and organizing emergency response efforts.

j. Mutual aid agreements shall be kept current and up-to-date. Site visits and drills shall be held with responding mutual aid groups sufficient to ensure effective and safe operations but in no case less than once per year. Compatible radio communications between sites and mutual aid groups shall be ensured.

k. Each site shall develop and maintain written Incident Command procedures that clearly describe emergency response procedures, roles and responsibilities, secession of command, emergency organization, communications, emergency action levels, and other information necessary for effective command and control.

References

NFPA 1500 - "Standard on Fire Department Occupational Safety and Health Programs"

NFPA 472 - "Hazardous Materials Incidents Responders, Professional Competence"

NFPA 1561 - "Fire Department Incident Command System"

OSHA Subpart 1910.156 - Fire Brigades

OSHA Subpart 1910.120 - Hazardous Waste Operations and Emergency Response

DOE/NFPA 1500 Implementation Plan (Memorandum from N. Goldenberg to Directors, dated September 1988)

DOE Order 5480.7A - Fire Protection

DOE REFERENCED FIRE PROTECTION CRITERIA

Code of Federal Regulations (CFR) 29, Part 1910, Occupational Safety & Health Standards

CFR 29, Part 1926, Safety & Health Regulations for Construction

National Fire Protection Association (NFPA) Codes and Standards

Other DOE Orders and statutory requirements, not listed above, that contain requirements of a more limited extent relating to the DOE Fire Protection Program.

DOE/EP-0108. "Standard for Fire Protection of AEC Electronic Computer Data Processing Systems" (DOE)

DOE/EV-0043, 8-79, "Standard on Fire Protection for Portable Structures" (DOE)

DOE Fire Protection Resource Manual.

National Fire Protection Association Handbooks.

Factory Mutual Loss Prevention Data Sheets.

Society of Fire Protection Engineers (SFPE) Handbook.

DOE Explosives Safety Manual, DOE/EV/06194.

Local and State fire protection criteria.

American Petroleum Institute Guidelines.

NFPA guides, manuals and recommended practices.

"Product Directories of Underwriters Laboratories," together with the periodic supplements (UL)

"Factory Mutual Research Corporation Approval Guide" (FM)