ACKNOWLEDGEMENTS

(1989 REVISIONS)

THIS GUIDE IS A CONSENSUS OF FIRE PROTECTION POLICES BETWEEN OPERATING CONTRACTORS AND ORO/SPRO FIRE PROTECTION ENGINEERING AND SHOULD BE UTILIZED UNDER ALL DESIGN, MODIFICATIONS, CONSTRUCTION, AND OPERATING CONDITIONS.

THE FOLLOWING CONTRACTORS PROVIDED CONSULTATION IN THE DEVELOPMENT OF THIS GUIDE.

OAK RIDGE NATIONAL LABORATORY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
OAK RIDGE, TN

Y-12 WEAPONS PRODUCTION FACILITY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
OAK RIDGE, TN

OAK RIDGE GASEOUS DIFFUSION PLANT
MARTIN MARIETTA ENERGY SYSTEMS, INC.
OAK RIDGE, TN

PADUCAH GASEOUS DIFFUSION PLANT
MARTIN MARIETTA ENERGY SYSTEMS, INC.
PADUCAH, KY

PORTSMOUTH GASEOUS DIFFUSION PLANT
MARTIN MARIETTA ENERGY SYSTEMS, INC.
PORTSMOUTH, OHIO

FEED MATERIALS AND PRODUCTION CENTER
WESTINGHOUSE MATERIALS COMPANY OF OHIO, INC.
FERNALD, OHIO

STRATEGIC PETROLEUM RESERVE PROJECT
BOEING PETROLEUM SERVICES
NEW ORLEANS, LA

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I. INTRODUCTION

These ORO/DOE Fire Prevention and Protection Policies are a supplement to U. S. Department of Energy Orders which are based upon principles long accepted within that portion of American industry that has been classified by their insurance carriers as "Highly Protected Risk." This term implies the ORO sites utilize qualified fire protection engineering judgment and comply 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 $37 billion, ORO has sustained an exemplary fire protection record and program.

There are several reasons for the ORO record. Above all is a goal-oriented program that requires a "Highly Protected Risk" level of fire prevention and protection that protects the public health and welfare, prevents undue hazards to employees, protects vital production processes, and requires that property damage be held to manageable levels. Additional objectives to assure the public trust and protect against environmental insults are increasingly important.

There is a requirement that every major site utilize the services of qualified fire protection engineers to obtain the highest economically justifiable level of industrial loss prevention and protection. The on-site 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 protection systems are maintained and serviced adequately to control changes in risks and hazards.

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

Strong leadership is provided by ORO with line management being held accountable to ensure contractors have programs in place which meet DOE requirements and with the Safety and Health Division providing oversight, technical support, and policy development.

This document was prepared as a consensus with Operating Contractors and has as its purpose the identification of program elements and policies that will maintain and improve performance in the future.

D. Howard

D. Howard, Director
Safety and Health Division

II. ELEMENTS OF FIRE PREVENTION AND PROTECTION PROGRAMS

DOE Order 5480.7. Fire Protection, directs ORO Contractors to operate "Highly Protected Risk" facilities characterized by a sufficient level of fire protection to fulfill requirements of insurability by Factory Mutual, Industrial Risk Insurers, or other private industrial fire insurance companies who limit their underwriting to the best protected class of industrial risks. Highly protected risk protection requires compliance with the fire protection and loss prevention standards detailed in DOE 5480.4, Environmental Protection, Safety, And Health Protection Standards and DOE 6430.1A. General Design Criteria.

In addition to the fact that DOE properties are non-insured, there are several important differences between DOE requirements and those of the private sector. These differences include: (1) DOE emphasis on Life Safety aspects of design (not a prime consideration for private property insurance); (2) DOE is responsible for funding of recommendations it makes, therefore, cost-benefit relationships must be considered; (3) DOE is involved in the production of national security related materials that may justify a higher level of protection; (4) DOE addresses protection of the public safety and health which may justify a higher level of protection; (5) Compatibility with regulatory requirements such as NRC may be recommended as a matter of policy; and (6) Major sites are required to maintain a qualified fire protection staff.

The following are program elements necessary for an acceptable ORO fire prevention and protection program:

Personnel and Functions

Within the DOE Contractor organizations, providing the administration of fire prevention and protection programs, there shall be one qualified person at each major facility who serves as a point of contact for the programs. This person shall be involved in the fire safety management functions of (1) identification & appraisal of fire safety problems, (2) development of fire prevention and loss control procedures, (3) communication of fire prevention and protection information, and (4) measurement of fire safety performance. The person shall function as the source of interpretation for facility management regarding the implementation of codes, standards, and acceptable industrial fire protection practices. They shall serve as the "Authority Having Jurisdiction" for all routine interpretation of DOE prescribed standards. They shall be granted and assured the authority and responsibility to communicate and act freely with the ORO or SPRO fire protection counterpart to promote a highly protected risk level of protection. The ORO or SPRO fire protection organization is the authority having jurisdiction for controversial matters.

The person functioning as the fire protection point of contact at each major operating contractor must assure that:

A. Proper fire protection design review and installation is provided for new construction and modifications.

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

C. Necessary inspection, testing and maintenance of fire apparatus, fixed protection, and fire protection water supplies are conducted and documented to assure reliable operation of equipment.

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

E. Compliance with DOE prescribed standards and the desired program of "Highly Protected Risk" classification is accomplished at the most reasonable cost.

"Highly Protected Risk" Application

Qualified fire protection engineering judgment shall be used to obtain the highest degree of fire protection consistent with reasonable economical costs. OSHA, NFPA Fire Codes and Prescribed Standards, recommended practices of Factory Mutual and Industrial Risk Insurers, and ORO-DOE should be followed; most stringent standards applies, however, interpretations regarding application of these codes and standards is necessary to provide the most favorable program. Deviations are expected under some circumstances when sufficient justification is established and documented. In all cases, facilities shall have the necessary fire protection, fire cut-offs, exits, alarms, water supplies, and detection systems, all of which are maintained in reliable condition.

Reasonable protection shall be provided to assure that hazards to life are eliminated, off-site contamination from fire is within regulatory limits, and that the maximum potential fire or explosion loss will not exceed $1,000,000. The specific property, process, or operation should be evaluated to determine a reasonable cost of protection and the potential for fire. If a higher standard of protection is justified, the credible fire loss should be generally limited to $250,000. The loss of production capability should be considered as well as the loss of public confidence or credibility. Contractor management should depend upon qualified fire protection personnel to provide the necessary information for an effective management decision.

Specific elements of a "Highly Protected Risk" fire protection program are outlined within DOE Order 5480.7. Fire Protection.

Economy of Program

To be consistent in establishing base fire protection and prevention program costs within ORO, actual expenditures that are reflected within department accounts should be reported fully in the annual fire protection report. Expenditures involving emergency medical services should be clearly identified separate from other fire department or fire protection costs. Where fire protection expenditures are used to maintain utility systems or building maintenance, this should be clearly identified in foot-notes.

When providing fire protection equipment, not only must the initial cost be considered, but complexity and frequency of inspection, life cycle costs, testing and maintenance of the equipment must be evaluated.

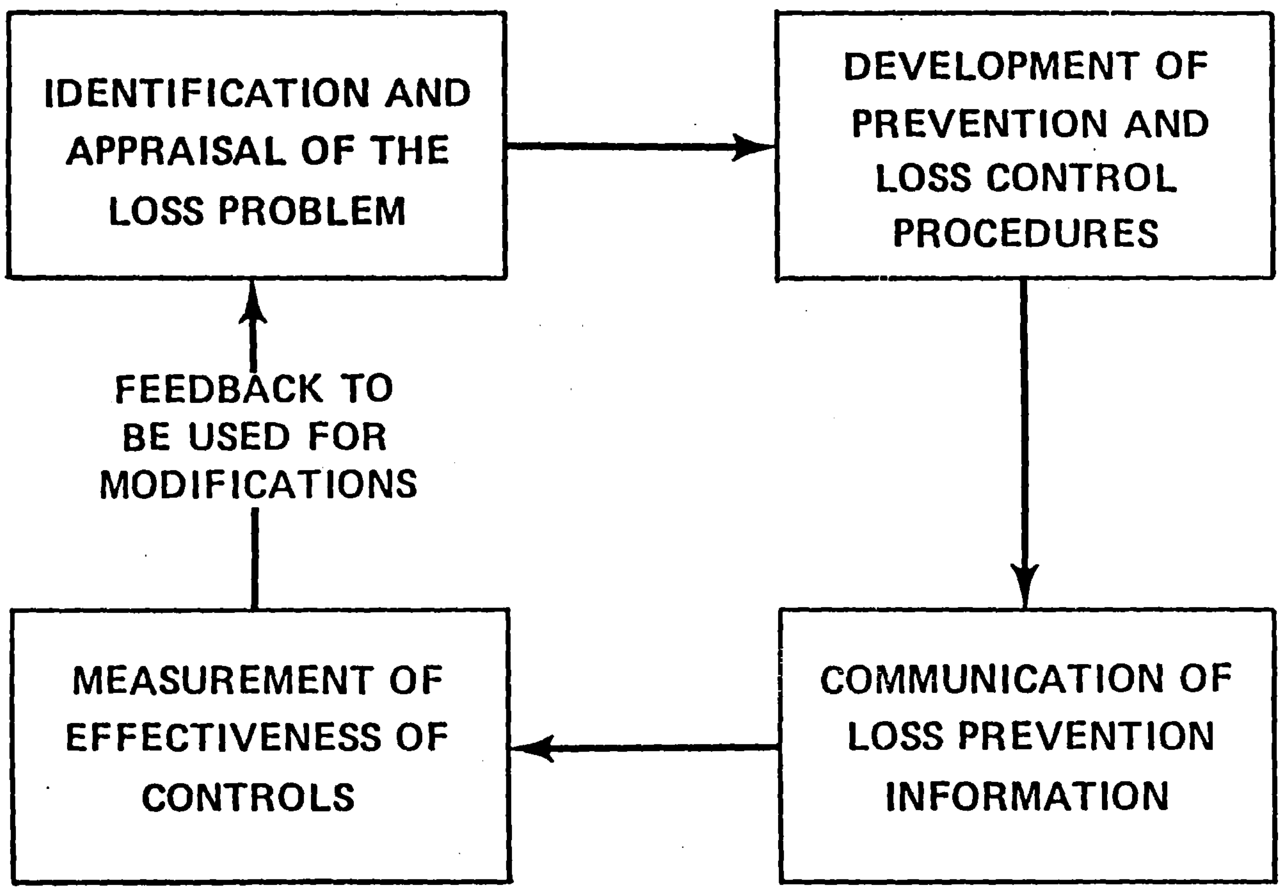
Since direct labor is practically all of the recurring program cost, efficient use of personnel should be made and the frequency of equipment inspection, testing and maintenance kept at an acceptable minimum consistent with reliable operation. Workload evaluations and adjustments are needed continually to meet changing conditions and plant experience. Attachment "A" is a typical workload schedule which should be used to establish staffing needs. A formal work-load analysis should be conducted and documented at least every three years to assure efficient operations, with the analysis made available at ORO functional appraisals.

Program Evaluation

According to DOE Order 5480.7, an annual report is required by each facility which includes the major fire protection accomplishments for the year, objectives for the coming year, recurring loss prevention costs, and loss experience. In preparation of this report, each facility reviews and evaluates its respective program.

For more comprehensive reports, the following items are recommended for inclusion within the annual report; (1) personnel staffing numbers, (2) cost breakdown for fire department operations and fire protection engineering, (3) fire equipment and motorized apparatus installed, (4) mutual aid activities, (5) outside audits completed by others, (6) identification of risks and vulnerabilities, (7) fire loss experience with descriptions where fixed fire protection systems operate or a fire resulting in death, injury, or loss exceeding $5,000, (8) fire protection and prevention activities, (9) number of incident responses, (10) objectives for coming year, and (11) other items of interest.

ELEMENTS OF THE FIRE PROTECTION POSITION



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

SIZING THE FIRE DEPARTMENT FORCE BY WORK LOAD 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 WORK FORCE NEEDS

	A	B	C	D
Work Category	Estimated PH	PH @ 70% Effectiveness (A x 1.3)	No. of persons 5 day coverage (B - 1800)	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

*Note: Structural fire response requires a minimum of 5 persons. Ambulance response requires 2 persons.

III. PERFORMANCE RATING GUIDE - FIRE PROTECTION

The enclosed rating guide will be used for performance determinations of fire protection programs.

The guide will be used as a basis to determine deviations of either better or worst performance. The "Performance Rating Scale" is as follows:

PERFORMANCE RATING SCALE

Adjective Rating	Definition	Performance Points
Superior	Performance exceeds standard 1/by a substantial margin. Few elements for improvement are identified, all of which are minor.	96-100
Excellent	Performance exceeds standard. Although there may be several elements for improvement, these are more than offset by better performance in other elements.	86-95
Good	Performance is standard. Elements for improvement are approximately offset by better performance in other elements.	76-85
Marginal	Performance is less than standard. Although there are elements of standard or better performance, these are more than offset by lower graded performance in other elements.	61-75
Unsatisfactory	Performance is below minimum acceptable. Improvement in overall contract performance is required to avoid possible termination action.	60 & below

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1/ The standard for measuring contractor performance is the performance level normally expected of a competent contractor. This corresponds to a numerical rating of 80 points on the rating scale and to fee paid under a cost-plus-fixed-fee contract. Performance points will reflect deviations from the standard in the direction of either better or worse performance. Performance ratings above the standard level will reflect the extent to which the contractor, on his initiative, is actively involved in performance improvement activities and the extent to which these actions contribute to more efficient, effective, and economical operations.

ORO FIRE PROTECTION AND DEPARTMENT PERFORMANCE RATING GUIDE

ELEMENTS	WEIGHT	RATING
FIRE PREVENTION		
FIRE PROTECTION		
FIRE SUPPRESSION		
MANAGEMENT & COMMUNICATION		
INNOVATIONS		

Total Rating ________

FIRE PREVENTION

1. Review of plans for new construction
2. Regular self-inspection, tests, engineering reviews
3. Outside consultant review findings
4. Quality Assurance Application
5. Administrative Controls to avoid impairments
6. Fire prevention education
7. Housekeeping

FIRE PROTECTION

8. Physical barriers such as firewalls, firedoors, isolation
9. Quality construction
10. Enclosure of vertical openings

11. Protection of Special Hazards

    a. storage
    b. hot work
    c. flammable liquids
    d. combustible dusts
    e. combustion controls
    f. others

12. Reliable fire water supplies

13. Automatic and manual alarms

14. Automatic sprinkler systems

15. Emergency Egress

FIRE SUPPRESSION

16. Emergency preplanning

17. Training

18. Procedures

19. Staffing of emergency response

20. Equipment maintenance

21. Mutual aid agreements

22. Emergency response organization

MANAGEMENT & COMMUNICATIONS

23. Management support & organization

24. Funding of recommendations

25. Responsiveness to improvements

26. Reporting

27. Problem solving

28. Loss record

29. Safety Analysis Review support
30. Cost controls
31. Compliance with and enforcement of DOE prescribed standards
32. Staffing and support of professional staff

INNOVATIONS

Initiatives taken to improve the fire protection and fire department programs which exceed expected performance levels.

IV. FIRE PROTECTION ACCIDENT AND IMPAIRMENT NOTIFICATION GUIDE

ORO Fire Protection requests notification of fire and explosion accidents, and significant emergency impairments of fixed fire protection systems regardless of the magnitude. By having such losses and emergency 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 investigation by knowledgeable staff, can result in a level of protection or attention which will minimize the chance of recurrence. This information is also used to determine trends in ORO facilities.

At Government owned facilities, it is a fundamental responsibility that information concerning issues relating to the safety and health of the public and employees be shared in a timely, clear, and precise manner by Contractors.

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

TYPE OF LOSS OR IMPAIRMENT	REPORTING TIME
- Loss above $1000.	Immediate
- Fire or explosion involving release of nuclear material outside of building or area.	Immediate
- Fire or explosion involving offsite release	Immediate
- Fire initiated fixed fire protection system operation	Immediate
- Incendiarism or malicious intent is suspected	Immediate
- Improper impairment of fixed fire protection system discovered.	Immediate
- Adequate fire water supplies unavailable	Immediate
- Underground fire water main break (6 inch or larger pipe)	>48 hrs
- Mobile fire department apparatus out-of-service	
One unit	>48 hrs
Two units	>24 hrs
Three units	Immediate
- Gravity supplies out-of-service	>8 hrs
- Major impairment to fixed fire protection (sprinklers, Carbon dioxide, Halon)	>24 hrs

- Fire alarm system 25% or greater out-of-service >24 hrs
- Automatic fire pump out-of-service >24 hrs
- Other loss or impairment as appropriate

Emergency Notification of fire, explosion, and emergency impairments listed in this guide and other DOE Orders should be made by phone to the Oak Ridge Operation Emergency Operations Center.

At SPRO, emergency notification should be made in accordance with procedures defined by the project office.

NOTES: 1) When outages exceed the times specified they shall be reported.

2) Protection systems may be included in environmental emergency contingency plans and impairments may require to be reported to EPA.

3) An "unusual occurrence report" shall be prepared for all improper impairments of fire protection systems or devices and reported to ORO or SPRO within 24 hours.

An "unusual occurrence report," "quality incident," or "quality event" report should be prepared, as applicable, for all failures of fire protection systems or devices.

V. FIRE PROTECTION PLAN REVIEW

A. Purpose

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

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. Procedures

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

   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, or DOE Form No. 1, Design Review Record, to document all design reviews for new buildings or major modifications.

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
- 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

3. Pipe drawings.

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

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 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
   - 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

- Communications
- 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 & Permits
- Material Storage
- Temporary Trailers
- Temporary Fuel-Fired Heating
- Accessibility
- Test and Acceptance Procedures
- Protection Impairment Procedures

ATTACHMENT 2

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

VI. DETERMINATION OF MAXIMUM AND SIZE OF A SINGLE FIRE AREA

SCOPE

This section provides guidelines and references for maximum possible fire loss, fire walls and space separation. DOE 6430.1A and 5480.7 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 "Improved 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 $25 million, the area shall be subdivided with free-standing fire rated walls or suitable redundant fire protection systems to limit the credible loss to less than $25 million even in the event the primary system fails. In no case shall the maximum loss potential exceed the $75 million loss limit established in DOE 5480.7; failure-proof systems such as physical separation or rated fire walls shall be provided to prevent this possibility.

STANDARDS AND REFERENCES (LATEST EDITIONS)

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

- DOE/EP-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 4700.1.
- All facilities shall include in their periodic fire protection engineering analysis 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. AUTOMATIC SPRINKLER SYSTEMS

Automatic sprinkler systems provide the most reliable known means for protecting structures and facilities from fire. Some of the more important criteria that make the sprinkler system so effective are: (1) It is designed to largely eliminate the human element; (2) Component parts and installation standards have been kept simple and consistent over the years; and (3) Actuation of sprinkler provides prompt extinguishing or controlling and in addition transmits an alarm to the proper emergency response organization. Sprinklers have a proven high effectiveness; the small factor of unsatisfactory performance can be traced to human error, attributable to closed control valves, inadequate or obstructed water supplies, and change in occupancy.

Installation of sprinklers can produce important savings in overall building costs by permitting larger fire areas, less space between buildings, less restrictive arrangements of occupancy and use of less costly construction materials. Evidence of the great value of automatic sprinkler protection is provided by the remarkable low-loss record of sprinklered buildings. In the decade before sprinklers were introduced, fire losses at properties insured by a leading group of industrial insurance companies averaged about 30 cents per $100 at risk. Today they average 4 cents. Although other factors have contributed, this reduction has been due largely to automatic sprinklers.

Without sprinkler, incipient fires may grow to destructive size and may ultimately result in a total structure loss. Sprinklers have prevented countless fires from reaching these destructive proportions and repeatedly have meant the difference between a minor business interruption and a prolonged or permanent production shutdown. Without the protection furnished by automatic sprinklers, it is unlikely that modern industry, with its extensive areas, hazardous equipment and processes, and high values in materials stored within single buildings, could have evolved as its exists today.

Automatic sprinklers are much more efficient than hose streams directed through windows from outdoors or through heavy smoke. Hose streams often drench an entire floor area without beneficial effect, particularly where the fire is hidden by smoke; far more water is used and much more water damage is experienced than would be expected from sprinklers. Many buildings are so large or so high that much of the area is beyond the reach of hose streams from outside. Heat and smoke can prevent fire fighters from approaching closely enough to be effective; however, sprinklers are brought into operation by heat and operate unhampered by heat and fire gases.

Automatic sprinklers are also important in the protection of life. Inhalation of hot gases has been responsible for many fire deaths. Loss of life in sprinklered properties has been small compared with that in unsprinklered properties. Sprinklers can detect and control fire effectively before hazardous heat, smoke and gas conditions are created.

Not only are the lives of workers protected, but also the lives of fire fighters.

The efficiency of sprinklers is shown by the relatively few heads that open in most fires to effect control. A study of industrial fires shows that of those where sprinklers operated, 76% were extinguished or controlled by five sprinklers or less of 95% by 25 sprinklers or less. At DOE sprinklers have been 98% effective in controlling or extinguishing fires, and about one-third are completely extinguished by the operation of a single sprinkler head.

Because of the care given to design, construction and assembly, and because of the rigid approval tests required, automatic sprinklers are among the most reliable mechanical devices made. Incidents of damage directly attributable of defective sprinklers are extremely rare.

Automatic sprinkler systems furnish the basic protection against serious damage from flammable liquid fires, regardless of the flash point of the liquid or of the presence of any additional special extinguishing system at the hazard. Sprinklers cannot extinguish fires in most low flash liquids, but they perform two important functions: (1) to prevent the fire from spreading by reducing its intensity and keeping the surroundings cool so that combustible material in the vicinity does not become ignited; and (2) to keep the building structure cool, including steelwork, thereby preventing collapse and complete wreckage.

<u>Pipe Schedule Installations</u>

The pipe schedule installation rules, which for years were the traditional guide for designers, are based on pipe schedules which, with an adequate water supply, assure enough water for each sprinkler. Systems designed according to pipe schedules have given good protection for many years and similar reliability can be expected in the future. The number of sprinklers fed by a given pipe size is determined by schedules given in sprinkler installation rules. Piping may be arranged in any of several configurations, but not in a loop system.

<u>Hydraulically Designed Systems</u>

Hydraulically designed systems are usually arranged to take advantage of the available water supply. In these systems, pipes are sized to provide a prescribed water density distribution with a reasonable degree of uniformity over a specified area. Designers use two general approaches - in both, the number of sprinklers fed by a given pipe size is determined from hydraulic calculations. Where the available water pressure is low, the pipe sizes used are larger than in the pipe schedule in order to obtain a minimum of friction loss. On the other hand, when available water pressures are high, pipe sizes smaller than those permitted by pipe schedules are used, and branch, cross and feed mains may be interconnected to get the required flow at sprinklers. Computers are used to speed up the design process and reduce the cost of the calculations.

Initial Savings vs. Long-term Loss

The initial cost of a hydraulically designed system may be lower than a system designed according to a pipe schedule because of the smaller piping required. However, since these systems are usually designed to supply the exact amount of water needed, they are frequently less able to accommodate changes in water demand when occupancy changes occur. A deterioration in public water supplies can have the same effect. Public water supplies frequently deteriorate over the years because of aging mains or increasingly greater water demands without reinforcement of the system. Public water systems without adequate supervision may be obstructed by shut valves and thus diminish water supplies. Cast-iron mains in private water systems, such as those with gravity tanks and fire pumps, will also deteriorate unless they are cement-lined. What this means is that sprinkler systems may have to be reinforced with additional feed mains or extensive piping revisions if occupancy changes result in a higher water demand or if water supplies have diminished for some reason. The pipe schedule system is usually easier to reinforce. It can be done with additional feed mains of a size that will make water supplies adequate again. Since many pipe schedule systems have built-in leeway, they may not need any reinforcing at all. Hydraulically designed systems, in some instances, may also be reinforced by additional feed mains. However, extensive repiping may be needed. In these instances, any earlier savings may be wiped out or exceeded by the additional cost. If there is reason to believe that an occupancy will change or that water supplies may deteriorate, it is advisable to design the system with excess capacity to realize a long-term saving.

The Importance of Accurate Water Tests

It is important to base calculations on the water supplies that will be available during fire. Since a fire can occur anytime, the lowest observed pressures and flows may be the most accurate. For instance, testing should be done at times of normal draft on the public water system. Public water supplies are likely to fluctuate widely from season to season and even within a 24-hour period. Allowance should be made for seasonal or daily fluctuations of drought conditions. Testing of private water supplies that are also used in production should be done during normal use.

A Review of Sprinkler Design Considerations

The advantage of a hydraulically designed sprinkler system over a pipe schedule system is primarily that of initial lower cost. The economic advantage of pipe schedule systems is that they are usually less costly to reinforce when occupancy changes or deterioration of public water supplies occur. The single feed type of hydraulically designed system may require costly pipe changes when occupancy changes or when deterioration of public water supplies occur. However, this may not be so in other designs. Accurate public water test data recorded during times of maximum use are important in both designs but are more important in hydraulically designed systems because they are usually designed much closer to the water supplies available.

The advantages or disadvantages of the two methods as given should be carefully weighed before a commitment is made on a sprinkler system design. In this way, an initial saving will be a permanent one.

Conditions under which automatic sprinklers are expected to perform well are rapidly changing, however, and we must be acutely aware that our older systems did not contemplate many of the conditions which we routinely encounter today. Warehouses designed for rack storage 20, 30, 50, feet high and more represent a challenge to even the most sophisticated systems; rubber tires and plastic storage are another set of problems - even the use of plastic packaging materials in general storage creates a fire control problem that is less than one generation old. There has been a number of large loss fires in sprinklered warehousing where the designed systems were not able to handle the "high challenge" fire when it occurred. In recognition of such problems, the familiar ordinary hazard or extra hazard sprinkler system installation is rapidly giving way to systems of more advanced design, systems of specified performance capability with performance specifications based upon data developed from realistic fire tests in the laboratory or from actual fire data.

Regardless of design, all sprinkler systems must be maintained in a state of readiness. The critically of inspection programs cannot be overemphasized. While a proven effectiveness of 95% is without a doubt commendable, the 5% factor of unsatisfactory performance is something which requires the greatest vigilance in all property conservation programs. In most cases, the cause of unsatisfactory performance can be traced to human error; most alarming is that the human error is most frequently an improperly closed sprinkler system or water supply control valve. Such occurrences are within the scope of total eradication through diligent valve inspection procedures as part of the plant self-inspection program and strict attention to the impairment notification procedure recommended by the insurance companies.

Well-designed and well-maintained sprinkler systems are essential to property conservation. The value of one sprinkler head operating in a timely and efficient manner exceeds by many times the cost of installation and the cost of maintenance. One can only ponder to what value property damage losses from fire would reach if it were not for automatic sprinkler systems.

GENERAL GUIDES FOR AUTOMATIC SPRINKLER SYSTEMS

1. DOE Orders 5480.7, 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 DOE/ORO plant site is responsible for the establishment, maintenance, and enforcement of design criteria for its fire protection and detection systems. Such criteria shall ~~are to~~ be ~~approved by~~ the site ~~plants'~~ cognizant Fire Protection Engineering Group as the "authority having jurisdiction" in code interpretation and implementation.

   Issues related to code interpretation, exemptions, design approvals, acceptance testing, and other issues which cannot be resolved by the Plant Fire Protection Engineering Organizations shall be referred to the ORO Nuclear Safety Branch or SPRO Environmental, Safety, and Health Division, as applicable, for resolution as the final "authority having jurisdiction" defined by NFPA Standards.

3. Sprinkler systems for Ordinary Hazard Occupancies should be designed according to conventional NFPA Standard No. 13, Pipe Schedule Sprinkler Designs.

   Exceptions which may require hydraulic designed systems include building with very high ceiling, long runs of feed or cross mains, limited water supplies, cooling towers, transformer protection, high piled storage and other types of special hazards and shall be installed only with the concurrence of the authority having jurisdiction.

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

5. Standard wet pipe automatic sprinkler systems should be given primary consideration. Use of pre-action, on-off systems, deluge sprinkler systems should be reserved for special consideration 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.

   New techniques of protection when proven reliable, cost-effective, and maintainable should not be overlooked. For example, the use of AFFF foam-water spray systems are effective for protection of low flash point flammable liquids.

Environmental consequences of sprinkler discharges must be considered during design.

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

7. All change of directions for underground fire water mains should be restrained by thrust blocks and one of the following methods: coated tie rods, or mechanical joints with retaining gland.

8. For small jobs or system modifications where the number of sprinkler heads is 39 or less, the designated agent (A-E, M&O Contractor, etc.) 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. Before awarding the contract, the seller shall submit written evidence of their qualifications.

9. Torch cutting/welding is not permitted to 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 from the approved documentation must be by written approval of the approving organization, authority having jurisdiction.

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. Pressure switches attached to an alarm-check valve, dry-pipe valve, or deluge valve are preferred.

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.

SPRINKLER PERFORMANCE UPDATE

CY 1988

The end of CY 1988 marks a milestone in the DOE record of sprinkler performance. It has now been 25 years since the last time an automatic sprinkler system failed to actuate and control or extinguish the fire in a DOE facility. Of the 205 incidents involving sprinklers and fire, 180 have occured since the 12/63 failure of a deluge system in a transformer fire.

Overall, the DOE record shows that sprinkler systems have extinguished or controlled the fire in 99.02% of the cases. Discounting the 12 incidents involving deluge systems, the record is 99.48% successful. For the 12 deluge system incidents, the performance was 91.7% successful.

The fires involving sprinklers that occured in 1988 are noted briefly below:

1. A 1/21 electrical fault in an elevator control room at the Y-12 Plant resulted in the ignition of hydraulic oil and the activation of a single sprinkler which controlled the fire and summoned the fire department to complete extinguishment. Loss was $30,000.

2. On 2/23, a 12,000v transformer at the Stanford Linear Accelerator Center ignited. A 20-head exposure deluge system was manually activated before the heat detectors operated, and prevented the fire from damaging the exposed building. Loss was $10,000.

3. A 4/13 electrical breaker failure at the Oak Ridge Technical Information Center resulted in a $20,500 loss when the resulting fire ignited office equipment. One sprinkler head operated and extinguished the fire.

4. At the Pantex Plant, on 4/27, leaking hydrazine ignited cartons and wood pallets. A single sprinkler head operated and extinguished the fire with only a $100 loss.

5. At the Y-12 Plant, on 5/26, welding slag ignited a mop head in a water treatment building. Again, a single sprinkler head extinguished the fire, confined to a small closet, for a loss of only $10.

6. The largest loss of the year, the series of electrical incidents at Lawrence Livermore Laboratory on 6/30, included the ignition of a small outdoor transformer. Two exposure heads operated and protected the adjoining building from any damage. Fire damage was negligible, as opposed to the totality of the electrical losses and electrical-caused losses ($3,465,000).

7. On 7/19, at the Y-12 Plant, another mop head fire resulted in

flames from the roof being drawn into the building by a ventilation fan. A single sprinkler head operated to control the fire and prevent extension into the building. Loss was $3,821.

8. On 8/7, some cardbopard boxes in a small cafeteria office at the Stanford Linear Accelerator Center were ignited. Again, a single sprinkler head extinguished the fire with a negligible loss.

The 1988 incidents again illustrate a fact that is becoming more obvious since the study of sprinkler performance was published for DOE in 1980. While every effort was made to go back through old records, and to have the plants search their files for the small-loss data, it is doubtful if all small incidents were recovered. A previous annual summary compared the data in that report with the record for just the years since then. Since 1980, we have required the reporting of all losses involving the operation of an automatic fire protection system, regardless of the dollar loss, if any. This more complete reporting makes it obvious that the overall record is undobtedly better than it appears, since it is apparant that far more one-head and negligible-loss fires are being reported now than were included when the 1980 report was researched. The mean number of sprinkler fires per year since 1980 has bee just under 10. Prior to then the mean was under 7, and the total number of reported fires, sprinklered and non-sprinklered has not increased significantly.

SPRINKLER FIRES SINCE 1980

If the 75 sprinklered fires that have occured since 1980 are considered to be more representative of the DOE record, due to better reporting, some interesting observations can be made, beyond the obvious one that the performance record is 100% effective.

In 33 fires, or 44% of the total, a single sprinkler head operated and extinguished the fire. The mean loss was $2,750. In another 17 fires, a single sprinkler head operated to control the fire, with a mean loss of $32,535.

The combined record for fires extinguished or controlled by the operation of a single sprinkler head is 2/3 of the total number of sprinkler fires, 66.7%. Mean loss for all single-head fires combined was $12,877.

There were 15 cases involving the operation of two sprinkler heads. In six of them, the fire was completely extinguished by the sprinklers, and controlled in the other nine cases. The mean loss for all two-head fires was $21,254. They accounted for 20% of the total number of sprinkler fires. More important, on a cumulative basis, %86.7% of fires in DOE properties were controlled or totally extinguished by the operation of not more than two sprinklers.

There were only three cases in which three sprinklers operated, none of which extinguished the fires unaided. On a cumulative basis, 90.7% of all fires were controlled or extinguished by the operation of three or less sprinkler heads.

Other incidents were too few in number to use for statistical purpose, there being only two cases each in which four and seven heads operated, one case each involving five, six, and nine heads, and none involving eight heads. But the nine-year record is remarkable in its totality; every one of the 75 fires was controlled or extinguished by less than ten heads. This further confirms the conclusions from the 1980 report as to the relative priority rankings of protection needs. Certainly, the provision of sprinklers throughout the protected premesis is the first priority. A water supply is almost incidental when 90% of the possible fires require less than a 10-head supply. (Reliability of the supply is another question). Further, there has never been a DOE fire where a redundant water supply was a necessity. For these reasons, DOE priorities can be simply stated as:

1. Comnplete sprinkler protection throughout the protected premises.

2. Adequate water supply, in pressure and volume, to supply at least 10 sprinklers.

3. Supervision of sprinkler control valves and any water supply failure points to ensure supplies are available.

4. Volume/pressure capability for large numbers of sprinklers.

5. Redundancy of supplies.

It should be noted that the above is for ordinary sprinklers. Obviously, deluge systems and hydraulically calculated systems for high-hazard areas will require greater suppies, since the number of heads to operate is known, or assumed to be, greater than for ordinary fires.

To summarize the record for the 75 sprinkler fire operations after 1980:

1. Every case was controlled or extinguished by nine heads or less.

2. There were no failures.

3. The fire was completely extinguished by the sprinklers, alone, in 43, or 57.3% of the incidents.

4. A single sprinkler head completely extinguished the fire in

44% of the total fires.

5. One sprinkler head extinguished or controlled the fire in two-thirds of the total number of fires.

6. Three or less sprinkler heads were all that operated in over 90% of the fires.

7. The mean loss per fire was $33,591. For those fires extinguished by the sprinklers, the mean loss was $9,254. For those in which the sprinklers controlled the fire, the mean loss was $66,295

DELUGE SYSTEMS

While few in number some analysis of the 12 deluge systems fires is of interest. The 12 fires were:

1. 10.54. Ion exchange column in a processing canyon. Extinguished by the system. Loss was $21,000.

2. 12/63. Transformer explosion. The transformer deluge system failed due to a hang-up of the actuating weight on the guide rod in the actuating mechanism box. Loss was $244,800. Ironically, the failure did not affect the magnitude of the loss as the transformer had exploded, breaking the sprinkler piping.

3. 5/65. Dust collector fire, controlled by the system. Loss was $2,400.

4. 5/66. A cooling tower fire was extinguished by the system. Loss was $15,300.

5. 7/66. Another cooling tower fire. Controlled by the system for a loss of only $395.

6. 6/67. A heat exchanger cell fire in a reactor was controlled by the system. Loss was $155,000.

7. 9/75. Another cooling tower fire. Controlled. Loss $7,000.

8. 5/76. Another cooling tower fire in a large tower (22 cells). Controlled for a loss of $15,300.

9. 7/77. A cooling tower fire. Controlled. Loss $450.

10. 7/80. A filter screen fire in a plutonium recovery facility. Controlled. Loss was $5,000.

11. 4/85. Uranium chips on a conveyor extinguished by the system

in less than two minutes. Negligible loss.

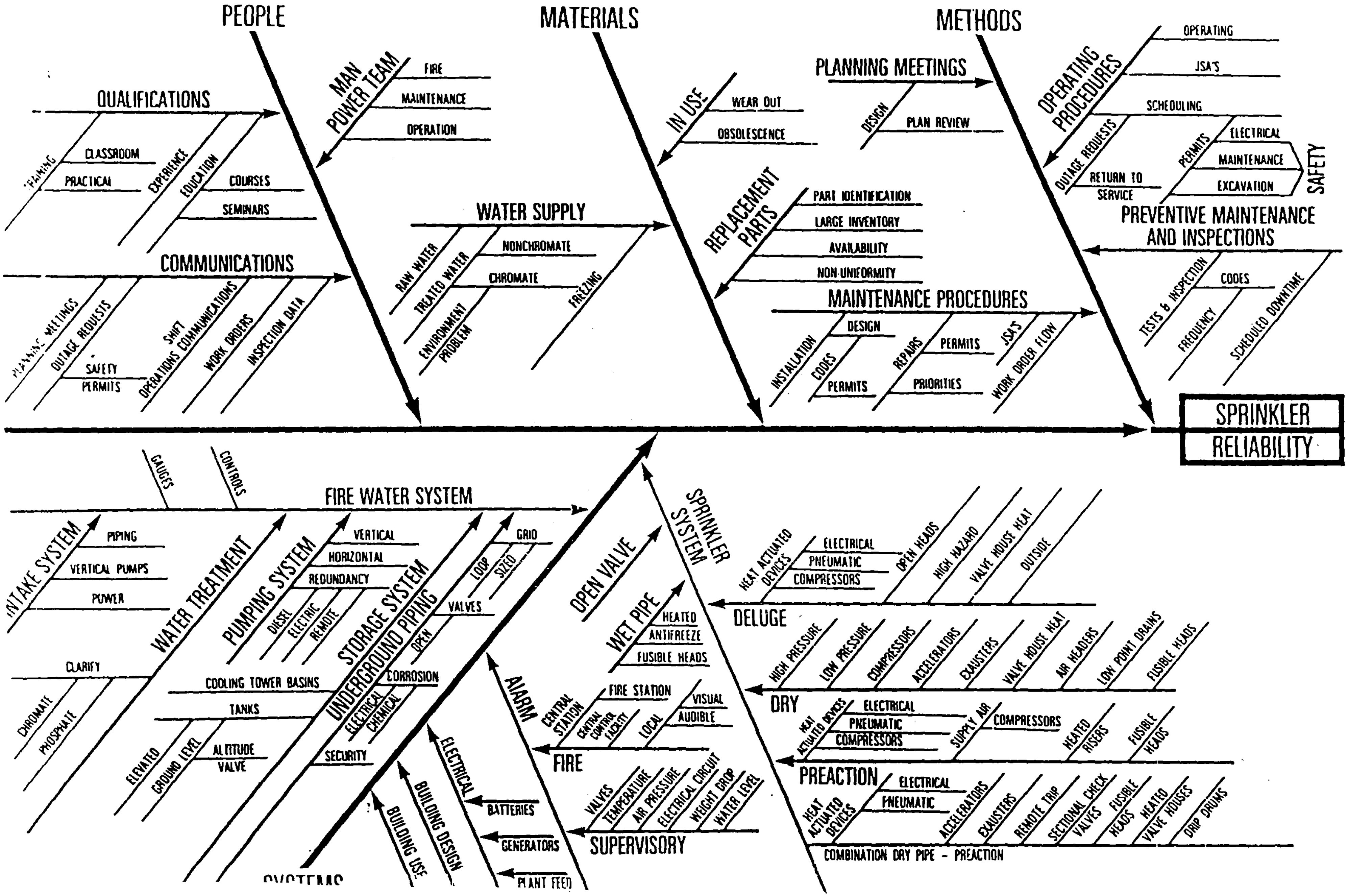
12. 2/88. Transformer fire in which a 20-head exposure protection system prevented damage to the building. Loss of $10,000.

The failure rate of 1/12 represents a 91.7% success rate.

The loss per fire was $39,720. If only the successful operations are considered, the loss per fire was $21,077.

The 1963 failure was the last sprinkler failure in DOE experience. The only other failure (a shut cold-weather valve) occured in 1958. There have been 180 sprinkler-fire incidents since the last failure.

SPRINKLER RELIABILITY



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 of 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 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.

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, we should 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. 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.

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 ____

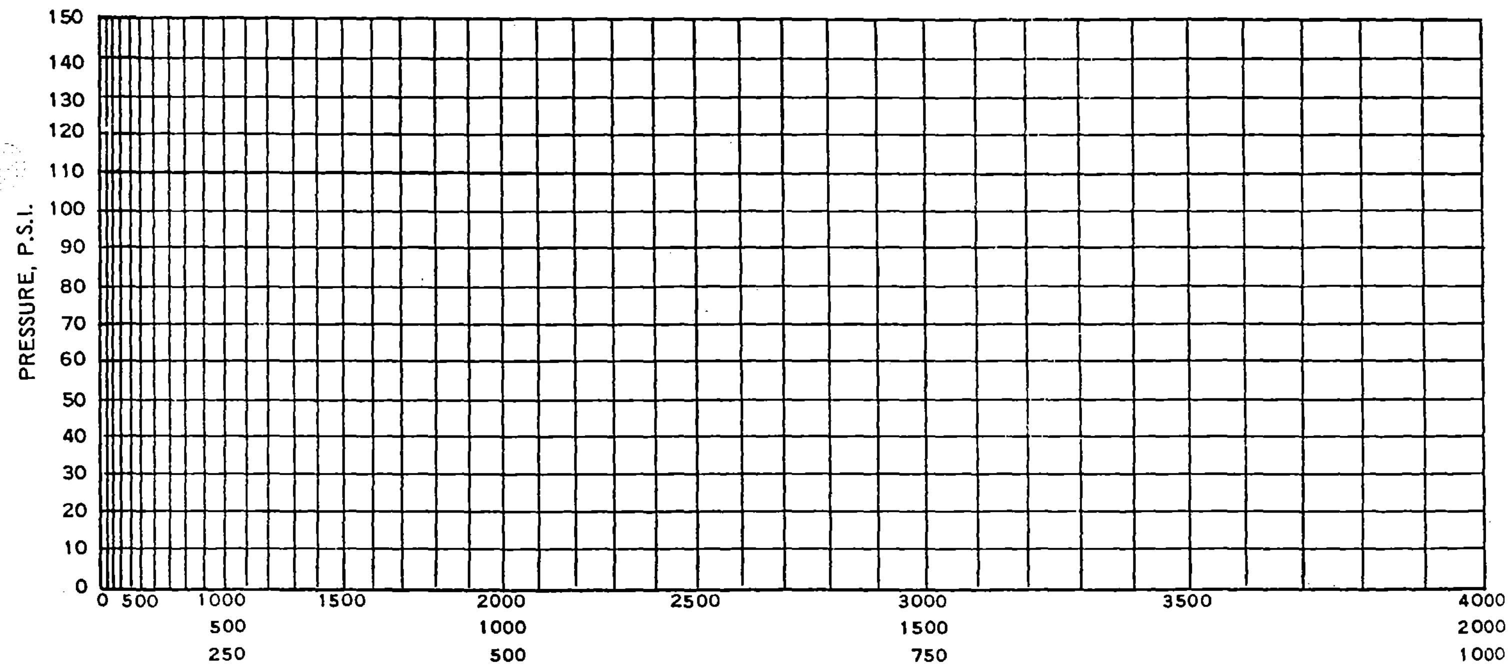
HYDRANT GAGE READINGS

	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. eq. F.M., I. R. I., N.F.P.A. etc.

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NOTES ON SUPPLY:

____

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Encl 1

UCN- 10182

IX. FIRE PUMP TESTING

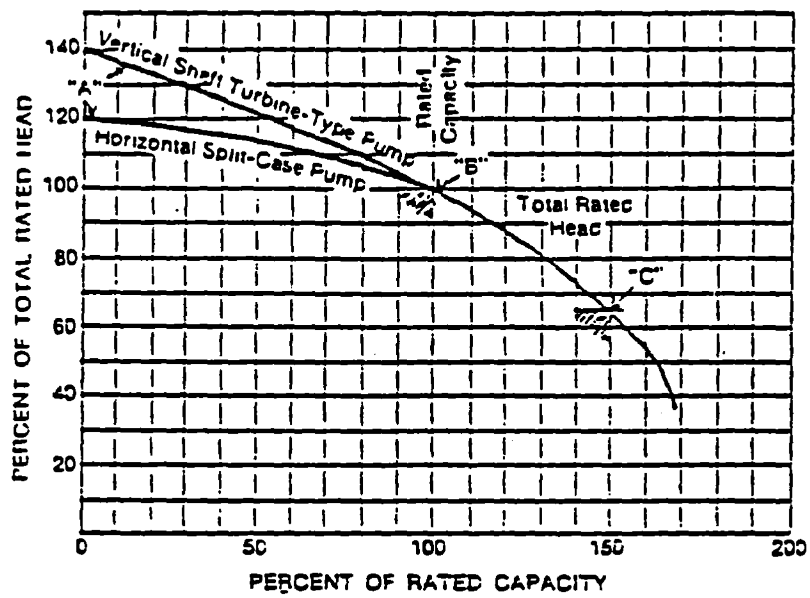
Inspection and Tests

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 <u>standard</u> fire pumps range from 500 to 4500 gpm. These fire pumps have a rated pressure of 100 psi or more. Pumps installed in <u>booster</u> 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

DATE	LOCATION	BY

PUMP NO.	TYPE TEST	MANUFACTURER

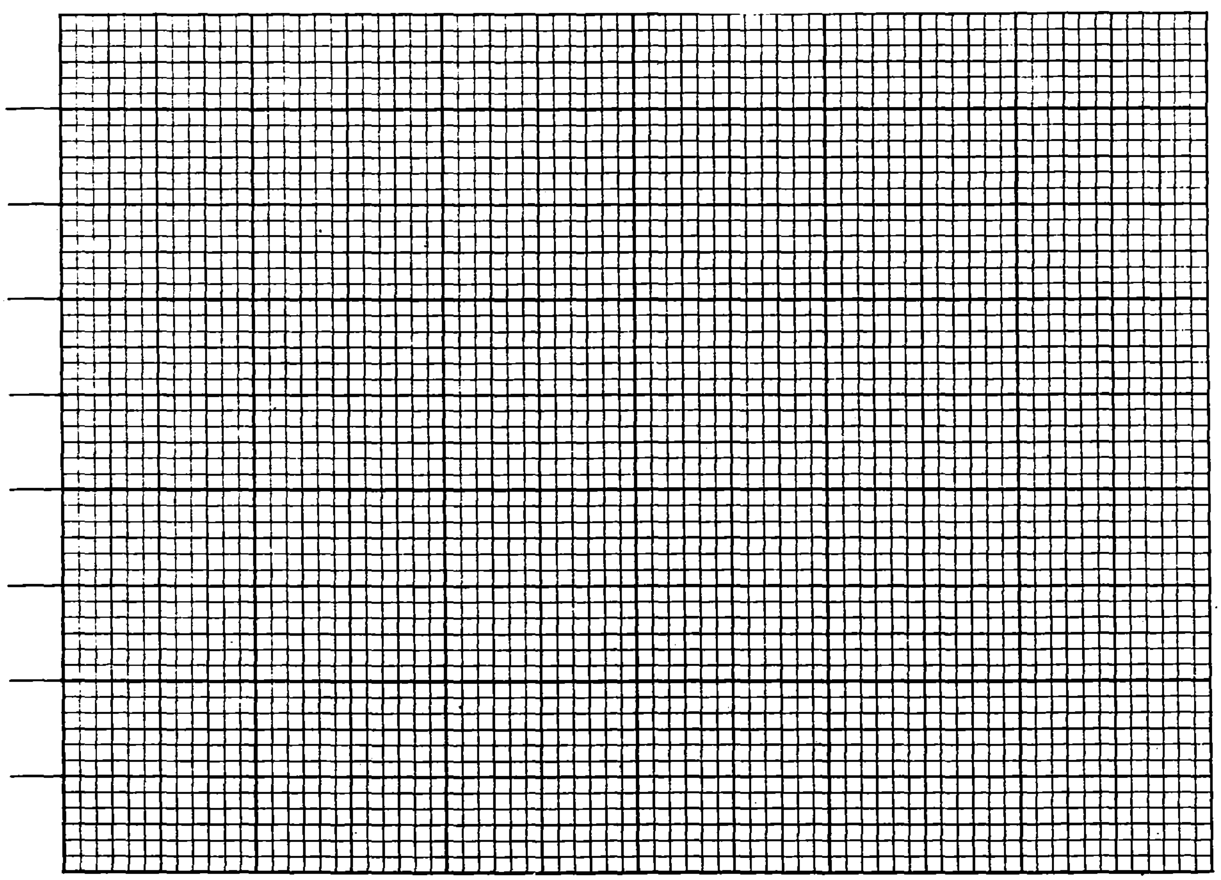
MANUFACTURER'S MODEL	SERIAL NO.	YEAR BUILT

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	

TEST - 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						

PRESSURE – PSI



FLOW – GPM

SUMMARY AND RESULTS

SHUT-OFF PRESSURE	PRESSURE AT 100% RATED FLOW	PRESSURE AT 150% RATED FLOW
PSI	PSI	PSI

REMARKS - (CONDITION OF PUMP)	NOTES

SUGGESTED 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 the 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 system 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 / FREQUENCY: FREQUENCY

6. High Engine Temperature Alarm — Semi-annual

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.

7. Overspeed Shutdown Position Alarm — Semi-annual

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.

8. Overspeed Shutdown — Annual

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 overspeed, no special testing of the solenoid fuel-valve is necessary since it is tested each time the engine is run.

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 — Semi-annual

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 should be pressed to reset the relay.

14. Manual Actuation at the Controller — Monthly

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.

15. Manual Remote Actuation — Semi-annual

Manual remote starting circuits should be tested semi-annually. Improper operation should not prevent local control of the engine controller. Circuitry should be supervised.

16. Automatic Start by Remote Equipment Control — Annual

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.

17. Automatic Engine Start Upon Loss of Power — Quarterly

This should be tested by opening the AC circuit to the controller at any convenient location.

18. Weekly Program Timer — Monthly

If provided, the operation of the timer should be observed by plant personnel. Under no circumstances should be the engine/controller be left unattended.

RECOMMENDED TEST / FREQUENCY: FREQUENCY

19. Running Timer — Monthly

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.

20. Sequential Starting For Multiple Pumps — Semi-annual

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.

21. Pump Room Alarms — Semi-annual

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.

22. Low Fuel Level — Quarterly

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.

X. ON-SITE FACILITY FIRE PREVENTION AND PROTECTION REVIEWS

Four basic types of facility reviews should be performed as part of a plant's overall fire prevention, protection and suppression program:

A. Construction Site and "Target Hazard" Inspections

B. Fire Prevention Inspections

C. Fire Protection Engineering Appraisals

D. Pre-Emergency Plans Development or Review

These reviews should be designed to provide appropriate information regarding a plant's building and equipment by technically trained personnel at regular intervals. Conditions and/or relative importance of a facility or progress may demand an increased review frequency. The goals of the review program are to insure a safe working environment for plant employees and the public and to prevent fire loss and interruption of critical operations. Fire safety is no accident . . . it is the result of planning.

A. Construction Site and "Target Hazard" Inspections

Construction site and "target hazard" inspections should be performed by qualified fire department/inspection personnel soon after close of the working day. Purpose is to check the locations for hazards that may create a fire situation while the building is unoccupied. Typical problems in these areas include: smoldering fires around welding/cutting sites; blocked hydrants, exits and fire lanes; unclosed valves on acetylene and oxygen cylinders; and shut valves on suppression systems. Inspections will be documented and a record maintained of all deficiencies. Corrective action will be taken within a reasonable period of time.

B. Fire Prevention Inspections

The fire prevention inspection is a survey scheduled on routine intervals where the inspector focuses his attention on the day-to-day practices and operations performed by personnel at work sites in his assigned areas. This inspection should include a review of topics such as housekeeping, storage and handling of flammable and combustible materials, condition of fire doors and exit doors, exit and emergency light operating conditions, heating equipment installations, portable and fixed fire protection equipment, and the use of chemicals and gases. The inspector's report should reflect the overall building condition from a fire prevention, protection and suppression point of view. A procedure should be developed whereby attention will be given to deficiencies and correction will be accomplished in a reasonable period of time. A follow-up inspection should be performed within a short time or as part of subsequent periodic inspections, depending on the seriousness of the hazard found.

C. Fire Protection Engineering Appraisals

1. Original

The fire protection engineering appraisal is an in-depth technical review and inspection of a building's structure, processes and equipment conducted by professional level fire protection personnel. It includes a hazards and risk evaluation of the entire facility and recommendations to improve fire prevention, protection, life safety, and suppression status. The report should be written in a manner to be self-explanatory as to the significance of particular hazards and the desirability of a viable solution. It should be presented to appropriate management level representatives so that proper attention and consensus solutions are reached for problems pointed out in the survey. Formal written reply by the management level person responsible for the specific building, facility or area should be required.

2. Re-Appraisals

Re-appraisals should be conducted in accordance annually for major buildings, vital program areas, or hazardous operations and biannually or triennially for less important buildings. The reappraisal should consist of a review of the original appraisal and the building for any changes. Any changes and recommendations resulting from the re-appraisal should be added to the original appraisal and presented to management. Reply from management level persons should be required in the same manner as for the original appraisals.

D. Pre-Fire/Emergency Plans

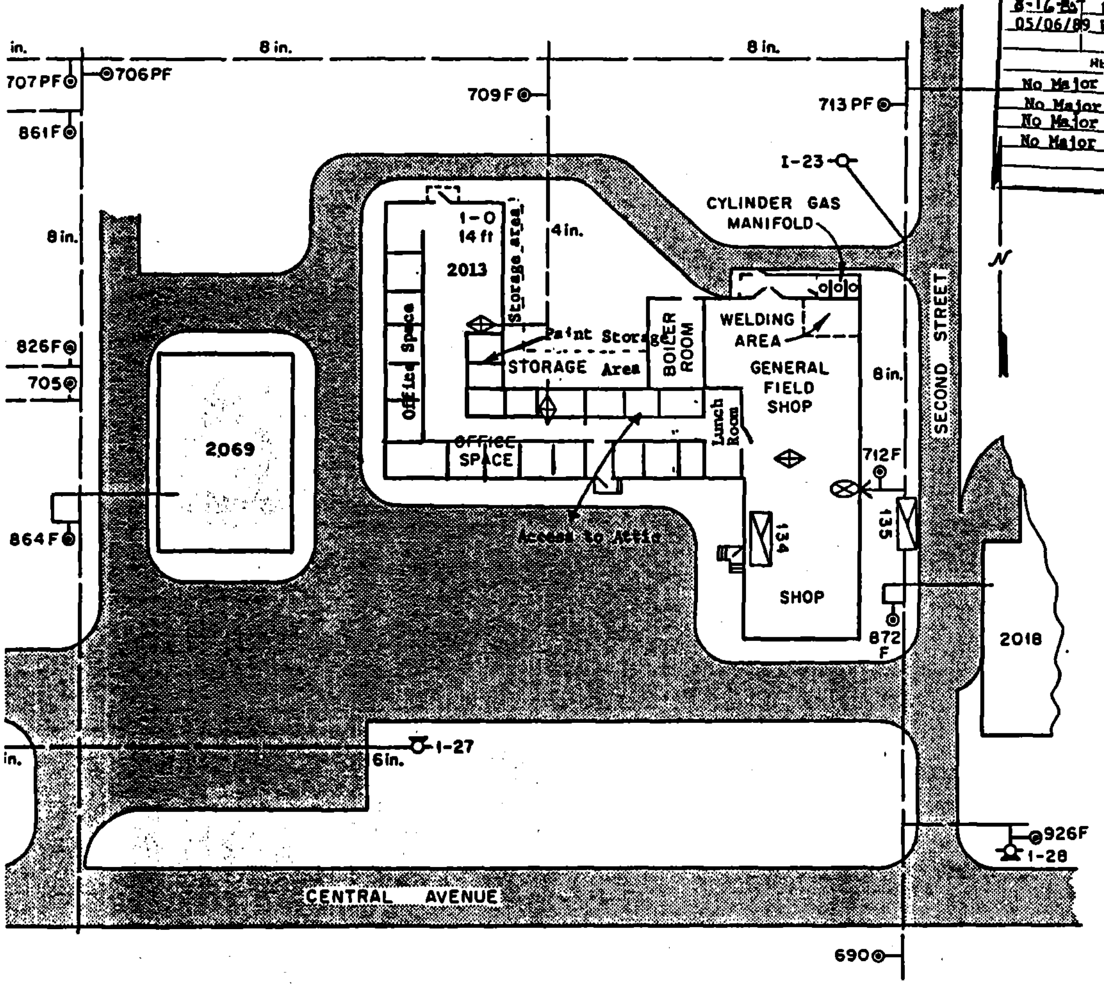
Written pre-emergency plans should provide as much beforehand knowledge as possible so that the responding emergency forces can intelligently attach the fire and/or handle the emergency. Information pertaining to building layout, hazards and protective facilities should be simply and briefly stated, (see sample plans, Attachment "A") and kept in reference book form so that it will be readily available. These plans should be used for fire brigade training exercises and changes should be made when necessary. All facility plans should be updated on a minimum three-year interval. Pre-fire/emergency plans shall meet the needs of first line officers at each site.

PRE-PLANNED FIREFIGHTING PROCEDURE
BUILDING 2013

REVISED BY J.L. JOHNSON 4-9-80

2013

ORNL FIRE & GUARD DEPARTMENT	
REVIEWED & REINSPECTED BY:	
DATE	NAME
6-21-78	J.A.Fields
4-9-80	J.L. Johnson
6-13-82	W.L. Whaley
8-16-85	HG Lovelace
05/06/89	W. D. Jones
REMARKS	
No Major Change	
No Major Changes	
No Major Changes	
No Major Changes	



ACTION: SOUND ADDITIONAL ALARMS AS NEEDED. SHUT OFF ELECTRICAL POWER (MAIN SWITCH IN NORTH ROOM OF 2013). SHUT OFF CYLINDER GASES AT THE N.E. CORNER OF BUILDING. BOOST WATER SUPPLY TO SPRINKLER SYSTEM THROUGH SIAMESE AT S.E. CORNER OF BUILDING. VENTILATE THROUGH DOORS AND WINDOWS. VENTILATE ATTIC BY OPENING ROOF OVER AREA INVOLVED, THROUGH HATCHWAYS AND BY ENERGIZING ATTIC FANS.

CAUTIONS: DRAFT STOP DOORS IN ATTIC SHOULD BE CLOSED IF ATTIC IS INVOLVED. PIPING AND LOW ATTIC FRAMING PRESENT BUMPING AND TRIPPING HAZARDS. PROTECT CYLINDER GASES IN MANIFOLD AT N.E. CORNER OF BUILDING, PIPED INTO WELDING SHOP.

CAUSES: LEAKING GASES, WELDING AND OPEN FLAMES IN NORTHEAST CORNER OF SHOP. SMOKING AND ELECTRICAL HAZARDS.

ACCESS: FIVE DOORS TO THE OUTSIDE PROVIDES ADEQUATE EMERGENCY EXITS. THREE ON THE NORTH AND TWO ON THE SOUTH. TWO WALL LADDERS PROVIDE ACCESS TO THE ATTIC THROUGH HATCHWAYS.

EXPOSURES: WOODEN BUILDING 2018 LOCATED ON THE EAST SIDE AND METAL CLAD BUILDING 2069 LOCATED ON THE WEST SIDE. BOTH ARE FULLY SPRINKLED.

OCCUPANCY: THIS BUILDING IS OCCUPIED BY PERSONNEL OF PLANT AND EQUIPMENT DIVISION, HOUSING THE WEST MAINTENANCE SERVICE CENTER, WITH SHOP AND OFFICE SPACE. THE WEST SECTION HOUSES P & E DIVISION SAFETY OFFICE, PROGRAMMED MAINTENANCE SECTION AND OTHER P & E OFFICE PERSONNEL AND STORAGE SPACE.

CONSTRUCTION: THIS IS A ONE STORY WOOD FRAME BUILDING WITH EXTERIOR WALLS OF ALUMINUM SIDING. INTERIOR WALLS, PARTITIONS AND CEILINGS ARE CONCRETE, TRANSITE AND SHEET ROCK ON WOOD STUDS. IT HAS A FULL ATTIC WHICH IS PROVIDED WITH TWO DRAFT STOPS OF TRANSITE ON WOOD STUDS AND EQUIPPED WITH AUTOMATICALLY CLOSING DOORS. THE ROOF IS CONSTRUCTED OF WOOD RAFTERS AND SHEATHING COVERED WITH ASPHALT SHINGLES.

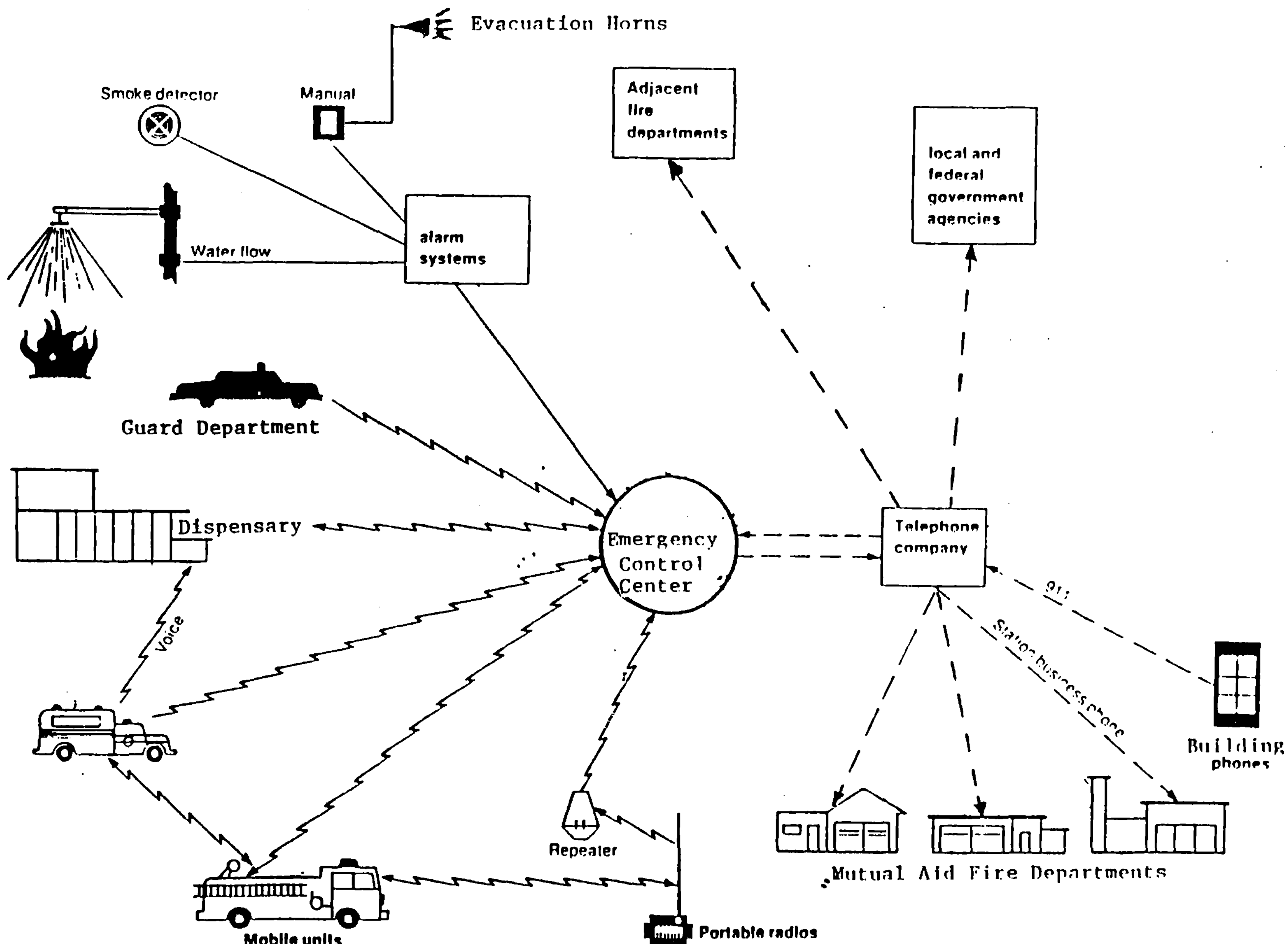
FIRE PROTECTION: ONE WET TYPE AUTOMATIC SPRINKLER, MONITORED BY ALARM BOX 134, PROVIDES FULL PROTECTION.
AN ADEQUATE SUPPLY OF FIRST AID FIRE EXTINGUISHERS AND EIGHT FIRE HYDRANTS LOCATED WITHIN 390 FT. OF THE BUILDING.

RADIOLOGICAL HAZARDS: NONE.

LOSS POTENTIAL: THIS FACILITY MEETS THE "IMPROVED RISK" CONCEPT AND THERE IS NO LARGE LOSS POTENTIAL PRESENT.

Note: Paint storage area located inside the building.

UNION CARBIDE CORPORATION
NUCLEAR DIVISION
OAK RIDGE TENNESSEE



Communications system elements.

XI. FIRE EQUIPMENT INSPECTION, TESTING AND MAINTENANCE FREQUENCY SCHEDULE

The following are recommended frequencies for periodic inspection, test and maintenance of fire protection equipment and related systems at ORO facilities.

Proper inspection and maintenance 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 frequent inspection, test, and maintenance of fire protection equipment will help make certain that such equipment is ready and able to function as designed.

Inspection and tests should be conducted by competent personnel trained in the operation of fire protection equipment. Inspections should be recorded, deficiencies noted and reviewed by management with the funding authority to correct any deficiencies found, and a tracking system should be maintained to make certain that corrections are made in a timely manner.

Functional testing and maintenance should be as recommended by the manufacturer, NFPA code, or standards, and written plant operating procedures. Frequencies listed within this guide are intended to fully meet OSHA requirements and the intent of NFPA standards. The frequencies should be regarded as a minimum and specific vital, high risk, high value facilities or conditions may warrant increased surveillance schedules.

ORO facilities are required to incorporate the following into their programs:

1. Detailed Standard Operating Procedures and Quality Assurance Plans shall be maintained for the Fire Equipment Inspection, Testing, and Maintenance Programs.

2. All facilities should conduct internal audit and evaluation of the inspection, test, and maintenance programs and perform trend analysis on equipment failures and test/inspection frequency schedules.

NOTE: In some cases these test and inspection frequencies deviate from NFPA standards. Based upon ORO operating experience, dedicated fire department personnel, site fire protection engineering oversight, the need to balance staff and program needs, and as the "authority having jurisdiction" these deviations are determined acceptable by ORO/SPRO Fire Protection Engineering.

FIRE EQUIPMENT INSPECTION, TESTING AND MAINTENANCE FREQUENCY SCHEDULE

COMPONENT OR SYSTEM	ORO FREQUENCY	COMMENTS
BUILDING INSPECTIONS AND SURVEYS		
Fire Protection Engineering Surveys	Annually	Major or vital buildings
	As Needed	Service buildings
Fire Prevention Inspections	Monthly	Major or vital buildings
	Every 3 months	Service buildings
Pre-Fire/Emergency Plan	Every 3 years	New construction or major changes should be incorporated as built
	Annually	Reactors at X-10 Y-12: 9206 and 9212 Ports: X-345 and X-326
WET PIPE SPRINKLER SYSTEMS		
Visual Inspection	Monthly	Visual insp./control valve status
Remote Alarm Testing	Semiannually	Test from ITV to station
Main System Drain Test	Semiannually	Also perform after valve operation
Check Antifreeze	Annually	Perform prior to cold weather
Internal Examination	As Needed	See NFPA 13A for specifics
DRY PIPE SPRINKLER SYSTEMS		
Visual Inspection	Monthly	Visual insp./control valve
Remote Alarm Testing	Semiannually	Test alarm operations
Low Air Alarm Testing	Semiannually	Test by air reduction
Main Drain Test	Semiannually	Perform after each shut valve
Test Quick Opening Device	Annually	Test only quick open device
Check Low Point Drains	Annually	prior to cold weather
Internal Examination	As Needed	See NFPA 13A for specifics
Full Trip Test	Every 3 Years	Flood system with water

DELUGE SYSTEMS		
Visual Inspection	Monthly	Visual insp./control valve
Remote Alarm Testing	Semiannually	Test alarm system
Main Drain Test	Semiannually	After each shut valve
Test Manual Trip Device	Annually	Test may not discharge
Stainer Maintenance	Annually	Flush and clean
Inspect Nozzles	Annually	Verify not obstructed
Test Supervisory Alarms	Semiannually	Valve supv., low air, etc.
Test Detectors	Annually	Functional testing
Full Trip Test	Annually	Flow water
PREACTION SYSTEMS		
Visual Inspections	Monthly	Visual insp./control valve
Remote Alarm Testing	Semiannually	Test alarm system
Supervisory Air Alarm	Semiannually	Test low air alarm
Main Drain Test	Semiannually	And after valve closure
Test of Detectors	Annually	Functional test
Check Low Point Drains	Annually	Prior to cold weather
Full Trip Test	Annually	Flow water from ITV
FOAM SYSTEMS		
Visual Inspection	Monthly	Visual insp./control valves
Remote Alarm Testing	Semiannually	Test alarm system to station
Main Drain Test	Semiannually	And after valve closure
Discharge Flow Test	Annually	Verify system produces foam
Foam Quality Check	Every 3 years	Lab analysis of foam conc.
CARBON DIOXIDE SYSTEMS		
Visual Inspection	Monthly	Visual insp./control valves
Remote Alarm Tests	Semiannually	Functional test
Weighing of Hi-Press Cylinders	Semiannually	Replace if net loss exceeds 5 percent. (OSHA 1910.160)
Hydrostatic Testing of Cylinders	Every 12 years	Cylinders in continuous service and not discharged
Trip Testing	Annually	Puff test on low press systems

HALON 1301 SYSTEMS		
Visual Inspection	Monthly	Check press, controls, etc.
Remote Alarm Testing	Semiannually	Functional Testing
Maintenance and Weighing	Annually	Assure agent quantify
Test Detection Devices	Annually	Functional test of devices
Trip Test	Annually	Functional test of release device, no discharge
DRY CHEMICAL SYSTEMS		
Visual Inspection	Monthly	Check press, controls, etc.
Remote Alarm Testing	Semiannually	Functional test to station
Maintenance & Testing	Annually	Service, inspection and testing
FIRE PUMPS		
Visual Inspection	Monthly	Follow Mfg recommendations
Operating Churn Test	Monthly	Manual and remote start
Automatic Test	Every 3 months	Drop in pressure or water level
Controller Check	Annually	Check all interlocks
Flow Meter Calibration	Every 5 years	Calibrate with known flow
Flow Test to 150%	Annually	Record data
UNDERGROUND FIRE MAINS		
Flow/Loop Testing	Annually	Record flow results
Hydraulic Gradient	As Needed	Perform as needed by flow test results
Curb Box Control Valves	Annually	Operate and Spring test open
FIRE HYDRANTS		
Visual Inspection	Annually	Check for damage and leaks
Maintenance of Hydrants	Annually	Lubricate and repair
Flush	Annually	Full flow and verify drainage

FIRE PROTECTION CONTROL VALVES		
Visual Inspection	Monthly	Assure valves open
Valve Tamper Alarm Test	Annually	Test to alarm station
Turn-Down Valve	Annually	Perform drain test after
Maintenance	Annually	Lubricate and inspect
FIRE ALARM SYSTEMS		
Supervisory Alarms	Semiannually	Test of circuit to receiving station
Fire Detectors	Annually	10% per year on ten year cycle
Smoke Detectors	Annually	20% per year on five year cycle Check sensitivity
Master Fire Boxes	Annually	Functional test circuit
Pull Stations	Annually	Functional test
Sprinkler Waterflow Alarms	Semiannually	Test at ITV bells, WMG
Employee Evacuation Alarms	Every 2 months	Nonsupervised systems (OSHA)
	Annually	Supervised Systems
FIRE ALARM MAINTENANCE		
Batteries	Monthly	Voltage, water, and cleaning
Test for Voltage & Grounds	Each Shift	Follow Mfg. instructions
Emergency Generator Load Test	Weekly	Start generator
FIRE EXTINGUISHERS		
Visual Inspection	Monthly	Verify work condition (OSHA)
Maintenance	Annually	Per Mfg. Instructions
Hydrostatic Testing	Every 5 years or	Per OSHA standards Table L-1
	Every 12 years	Per OSHA standards Table L-1
EMERGENCY LIGHTING		
Visual Inspection	Monthly	Inspect for obvious damage
Functional Testing	Semiannually	Lights function/batteries good

WATER STORAGE TANKS		
Tank Heating Systems	Annually	Prior to cold weather
Visual Inspection	Semiannually	Visual inspection of damage
Cathodic Protection	Annually	Inspection and maintenance
	Monthly	Tank-to-water potential
Interior Inspection	Every 5 years	Perform once every 5 years
FIRE HOSE		
Refold On Pumpers	Every 3 months	Inspect and maintain
Hydrostatic Test	Annually	Record results
Hose Station Hose	Annually	Rerack and visually inspect
Hose Stations	Every 3 months	Visual inspection
MOBILE FIRE APPARATUS		
Visual Inspection and Tests	Each Shift	Develop check sheet
Road Test	Weekly	Run at operating speed
Pump Test	Weekly	Assure reliability
Flow Capacity Tests	Annually	Per NFPA standards
FIRE DOORS		
Visual Inspection	Monthly	Verify doors in good repair
Operability Tests	Annually	Functional test of doors
Exit Doors and Signs	Semiannually	Full operational test
SMOKE AND HEAT VENTING		
Test and Inspection	Annually	Full operational test
FIRE DAMPERS		
Test and Inspection	Annually	20% inspected on a 5 year cycle

ANTIFREEZE LOOPS Test & Inspection	Before Freezing Weather	Check specific qravity by sampling the solution.
Visual Inspection	Monthly	Assure valves are open.
SELF CONTAINED BREATHING APPARATUS Service Check	Weekly Monthly After Each Use	Visual Inspection. Detailed Inspection. See NFPA 1404.
Maintenance	Annual	According to manufacturer's instructions and NFPA 1404.
Cylinder Test & Maintenance	According to manufacturer	Hydrostatic test, internal, and external inspection.
Breathing Air	Every three (3) months	Air quality check by a qualified laboratory.
Program Review	Annual	Review respiratory protection policies and procedures.