Maintenance Schedule. The items shown in Table A-10-1.1 should be checked on a routine basis.

Table A-10-1.1 Maintenance Schedule

Parts	Activity	Frequency
Flushing piping	Test	5 years
Fire department connections	Inspection	Monthly
Control valves	Inspection	Weekly—sealed
	Inspection	Monthly—locked
	Inspection	Monthly—tamper switch
	Maintenance	Yearly
Main drain	Flow test	Quarterly
Open sprinklers	Test	Annual
Pressure gauge	Calibration test	
Sprinklers	Test	50 years
Sprinklers—high temp	Test	5 years
Sprinklers—residential	Test	20 years
Waterflow alarms	Test	Quarterly
Preaction/deluge detection system	Test	Semiannually
Preaction/deluge systems	Test	Annually
Antifreeze solution	Test	Annually
Cold weather valves	Open and close valves	Fall, close; spring, open
Dry/preaction/deluge systems		
Air pressure and water pressure	Inspection	Weekly
Enclosure	Inspection	Daily—cold weather
Priming water level	Inspection	Quarterly
Low—point drains	Test	Fall
Dry pipe valves	Trip test	Annual—spring
Dry pipe valves	Full flow trip	3 years—spring
Quick-opening devices	Test	Semiannually

Appendix B Miscellaneous Topics

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

B-1 Figure B-1 shows acceptable methods for interconnection of the fire protection and domestic water supply.

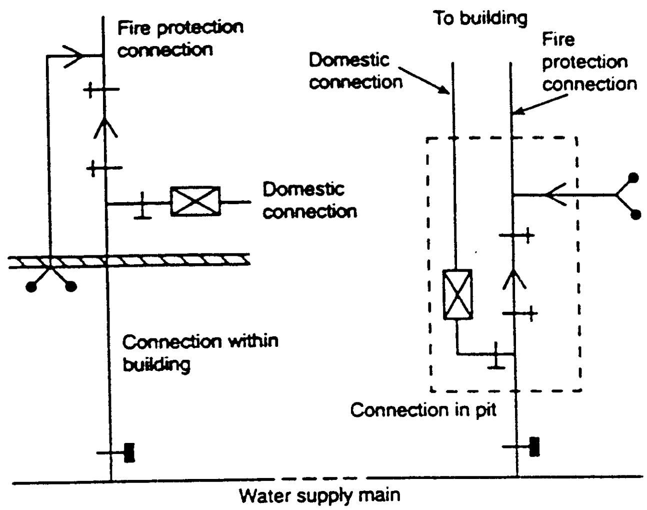

Figure B-1 Permitted arrangements between the fire protection water supply and the domestic water supply.

B-2 Sprinkler System Performance Criteria.

B-2.1 Sprinkler system performance criteria have been based on test data. The factors of safety are generally small and are not definitive, and can depend on expected (but not guaranteed) inherent characteristics of the sprinkler systems involved. These inherent factors of safety consist of the following:

(a) The flow-declining pressure characteristic of sprinkler systems whereby the initial operating sprinklers discharge at a higher flow than with all sprinklers operating within the designated area.

(b) The flow-declining pressure characteristic of water supplies. This is particularly steep where fire pumps are the water source. This characteristic similarly produces higher than design discharge at the initially operating sprinklers.

The user of these standards may elect an additional factor of safety if the inherent factors are not considered adequate.

B-2.1.1 Performance-specified sprinkler systems as opposed to scheduled systems can be designed to take advantage of multiple loops or gridded configurations. This results in minimum line losses at expanded sprinkler spacing, in contrast to the older tree-type configurations, where advantage cannot be taken of multiple path flows.

Where the water supply characteristics are relatively flat with pressures being only slightly above the required sprinkler pressure at the spacing selected, gridded systems with piping designed for minimal economic line losses can all but eliminate the inherent flow-declining pressure characteristic generally assumed to exist in sprinkler systems. In contrast, the economic design of a tree-type system would likely favor a system design with closer sprinkler spacing and greater line losses, demonstrating the inherent flow-declining pressure characteristic of the piping system.

Elements that enter into the design of sprinkler systems include:

(a) Selection of density and area of application.

(b) Geometry of the area of application (remote area).

(c) Permitted pressure range at sprinklers.

(d) Determination of the water supply available.

(e) Ability to predict expected performance from calculated performance.

(f) Future upgrading of system performance.

(g) Size of sprinkler systems.

In developing sprinkler specifications, each of these elements needs to be considered individually. The most conservative design will be based on the application of the most stringent conditions for each of the elements.

B-2.1.2 Selection of Density and Area of Application. Specifications for density and area of application are developed from NFPA and other standards. It is desirable to specify densities rounded upward to the nearest 0.005 gpm/sq ft (0.20 Lpm/m²).

Prudent design should consider reasonable-to-expect variations in occupancy. This would include not only variations in type of occupancy, but also, in the case of warehousing, the anticipated future range of materials to be stored, clearances, types of arrays, packaging, pile height, and pile stability, as well as other factors.

Design also considers some degree of adversity at the time of a fire. To take this into account, the density and/or area of application may be increased. Another way is to use a dual-performance specification where, in addition to the normal primary specifications, a secondary density and area of application is specified. The objective of such a selection is to control the declining pressure-flow characteristic of the sprinkler system beyond the primary design flow.

A case can be made for designing feed and cross mains to lower velocities than branch lines to achieve the same result as specifying a second density and area of application.

B-2.1.3 Geometry of the Area of Application (Remote Area). It is expected that, over any portion of the sprinkler system equivalent in size to the area of application, the system will achieve the minimum specified density for each sprinkler within that area.

Where a system is computer-designed, ideally the program should verify the entire system by shifting the area of application the equivalent of one sprinkler at a time so as to cover all portions of the system. Such a complete computer verification of performance of the system is most desirable, but unfortunately not all available computer verification programs currently do this.

This selection of the proper Hazen-Williams coefficient is important. New unlined steel pipe has a Hazen-Williams coefficient close to 140. However, it quickly deteriorates to 130 and, after a few years of use, to 120. Hence, the basis for normal design is a Hazen-Williams coefficient of 120 for steel-piped wet systems. A Hazen-Williams coefficient of 100 is generally used for dry pipe systems because of the increased tendency for deposits and corrosion in these systems. However, it should be realized that a new system will have fewer line losses than calculated, and the distribution pattern will be affected accordingly.

Conservatism can also be built into systems by intentionally designing to a lower Hazen-Williams coefficient than that indicated.

B-2.1.4 Ability to Predict Expected Performance from Calculated Performance. Ability to accurately predict the performance of a complex array of sprinklers on piping is basically a function of the pipe line velocity. The greater the velocity, the greater is the impact on difficult-to-assess pressure losses. These pressure losses are presently determined by empirical means that lose validity as velocities increase. This is especially true for fittings with unequal and more than two flowing ports.

The inclusion of velocity pressures in hydraulic calculations improves the predictability of the actual sprinkler system performance. Calculations should come as close as practicable to predicting actual performance. Conservatism in design should be arrived at intentionally by known and deliberate means. It should not be left to chance.

B-2.1.5 Future Upgrading of System Performance. It may be desirable in some cases to build into the system the capability to achieve a higher level of sprinkler performance than needed at present. If this is to be a consideration in conservatism, consideration needs to be given to maintaining sprinkler operating pressures on the lower side of the optimum operating range, and/or designing for low pipe line velocities, particularly on feed and cross mains, to facilitate future reinforcement.

Appendix C Referenced Publications

C-1 The following documents or portions thereof are referenced within this standard for informational purposes only and thus are not considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

C-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 1996 edition.

NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*, 1996 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 1996 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 1995 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 1995 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 1996 edition.

NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*, 1994 edition.

NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Motion Picture Film*, 1994 edition.

NFPA 58, *Standard for the Storage and Handling of Liquefied Petroleum Gases*, 1995 edition.

NFPA 72, *National Fire Alarm Code*, 1996 edition.

NFPA 80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*, 1996 edition.

NFPA 96, *Standard on Ventilation Control and Fire Protection of Commercial Cooking Operations*, 1994 edition.

NFPA 220, *Standard on Types of Building Construction*, 1995 edition.

NFPA 231, *Standard for General Storage*, 1995 edition.

NFPA 231C, *Standard for Rack Storage of Materials*, 1995 edition.

NFPA 231D, *Standard for Storage of Rubber Tires*, 1994 edition.

NFPA 231F, *Standard for the Storage of Roll Paper*, 1996 edition.

NFPA 291, *Recommended Practice for Fire Flow Testing and Marking of Hydrants*, 1995 edition.

NFPA 409, *Standard on Aircraft Hangars*, 1995 edition.

NFPA 703, *Standard for Fire Retardant Impregnated Wood and Fire Retardant Coatings for Building Materials*, 1995 edition.

C-1.2 Other Publications.

C-1.2.1 ANSI Publication. American National Standards Institute, Inc., 1450 Broadway, New York, NY 10018.

ANSI/ASME B1.20.1-1983, *Pipe Threads, General Purpose (Inch)*.

C-1.2.2 ASME Publication. American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.

ASME A17.1-1993, *Safety Code for Elevators and Escalators*.

C-1.2.3 ASTM Publications American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19105.

ASTM A 135-1993, *Standard Specification for Electric-Resistance-Welded Steel Pipe*.

ASTM E 119-Rev. A-95, *Standard Test Methods for Fire Tests of Building Construction and Materials*.

C-1.2.4 IMO Publications. International Maritime Organization, 4 Albert Embankment, London, SEI 7SR, United Kingdom.

International Convention for the Safety of Life at Sea, 1974 (SOLAS 74), as amended, regulations II-2/3 and II-2/26.

International Maritime Organization Maritime Safety Committee Circular 580, *Guidelines for the Application of Plastic Pipes on Ships*.

C-1.2.5 SNAME Publication. Society of Naval Architects and Marine Engineers, 601 Pavonia Ave., Ste. 400, Jersey City, NJ 07306.

Technical Research Bulletin 2-21, "Aluminum Fire Protection Guidelines."

C-1.2.6 UL Publication. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062.

"Fact Finding Report on Automatic Sprinkler Protection for Fur Storage Vaults," November 25, 1947.

C-2 The following NFPA documents contain specific sprinkler design criteria on various subjects.

NFPA 16A, *Standard for the Installation of Closed-Head Foam-Water Sprinkler Systems*, 1994 edition.

NFPA 231E, *Recommended Practice for the Storage of Baled Cotton*, 1996 edition.

Index

-T-

-U-

-V-

Bibliography of NFPA Standards

1 Fire Prevention Code
10 Portable Extinguishers
10R Portable Fire Extinguishing Equipment in Dwellings
11 Low-Expansion Foam
11A Medium- and High-Expansion Foam Systems
11C Mobile Foam Apparatus
12 Carbon Dioxide Systems
12A Halon 1301 Systems
13 Sprinkler Systems
13D Sprinkler Sys., Dwellings
13E Sprinkler Prop., F.D. Operations in
13R Sprinkler Sys., Res. Occ. up to and including 4 Stories
14 Standpipe, Hose Systems
15 Water Spray Fixed Systems
16 Deluge Foam-Water Systems
16A Closed Head Foam-Water Sprinkler Systems
17 Dry Chem. Ext. Systems
17A Wet Chem. Ext. Systems
18 Wetting Agents
20 Centrifugal Fire Pumps
22 Water Tanks
24 Private Fire Service Mains
25 Water-Based Fire Prot. Systems
30 Flam. Liquids Code
30A Automotive and Marine Service Station Code
30B Aerosol Products
31 Oil-Burning Equipment
32 Drycleaning Plants
33 Spray Application
34 Dipping and Coating Processes
35 Organic Coatings
36 Solvent Extraction Plants
37 Combustion Engines and Gas Turbines
40 Motion Picture Film
40E Pyroxylin Plastic
43B Organic Peroxide Formulations
43D Pesticides, Storage
45 Laboratories Using Chemicals
46 Forest Products, Storage
49 Hazardous Chemicals Data
50 Bulk Oxygen Systems
50A Gaseous Hydrogen Systems
50B Liquefied Hydrogen Systems
51 Welding, Cutting and Allied Processes
51A Acetylene Charging Plants
51B Cutting and Welding Processes
52 CNG Vehicular Fuel Systems
53 Oxy. Atmospheres, Fires in
54 Nat'l Fuel Gas Code
55 Compressed and Liquefied Gases in Portable Cylinders
57 LNG Vehicular Fuel Systems
58 LP-Gas Storage
59 LP-Gas, Utility Plants
59A LN-Gas. Stg., Handling
61 Agricultural and Food Products Facilities
65 Aluminum Processing
68 Venting of Deflagrations
69 Explosion Prev. Systems
70 *National Electrical Code*
70B Elect. Equip. Maint.
70E Electrical Safety in Employee Work
72 National Fire Alarm Code
73 Residential Elect. Maint. for Dwellings
75 Electronic Computer Systems
77 Static Electricity
79 Elect. Std. for Ind. Machinery
80 Fire Doors and Fire Windows
80A Exterior Fire Exposure, Prot. from
82 Incinerators, Systems & Equip.
86 Ovens and Furnaces
86C Ind. Furn., Sp. Processing
86D Ind. Furnaces, Vacuum
88A Parking Structures
88B Repair Garages
90A Air Conditioning Systems
90B Warm Air Htg., Air Cond.
91 Exhaust Syst. for Air Conveying of Materials
92A Smoke-Control Systems
92B Smoke Mgmt. Syst. in Malls, Atria, Large Areas
96 Commercial Cooking Operations
97 Heating Terms, Glossary
99 Health Care Facilities
99B Hypobaric Facilities
101® Life Safety Code
101A Alt. Approaches to Life Safety
102 Grandstands, Folding/Telescopic Seating, Tents, and Membrane Struct.
105 Smoke-Control Door Assemblies
110 Emer., Standby Power Systems
111 Stored Electrical Energy Emer. & Standby Power Systems
115 Laser Fire Protection
120 Coal Preparation Plants
121 Self-Propelled & Mobile Surface Mining Equip.
122 Underground Metal and Nonmetal Mines
123 Undergr. Bituminous Coal Mines
130 Fixed Guideway Transit Systs.
150 Racetrack Stables
170 Fire Safety Symbols
203 Roof Coverings/Roof Deck
204M Smoke, Heat Venting
211 Chimneys, Fireplaces, Vents
214 Water Cooling Towers
220 Types Bldg. Construction
231 General Storage
231C Rack Storage of Mat'ls.
231D Rubber Tires, Storage
231E Baled Cotton, Storage
231F Roll Paper, Storage
232 Records, Prot.
232A Archives and Records Centers
241 Construction, Alteration, and Demolition Operations
251 Bldg. Constr. & Mat'ls., Fire Tests
252 Door Assem., Fire Tests of
253 Floor Covering Systems, Test for
255 Bldg. Mat'ls., Burning Character
256 Roof Coverings, Tests of
257 Window Assemblies, Tests of
258 Smoke Generation, Test of
259 Heat of Bldg. Mat'ls., Test for
260 Cig. Ignition Resistance—Components of Furniture, Tests for
261 Cig. Ignition Resistance—Uphol. Furn. Assem., Tests for
262 Wires and Cables, Test for Fire and Smoke Char. of
263 Heat & Smoke Release Rates, Test for
264 Heat-Release Rates Using Oxygen-Consumption Calorimeter, Test for
264A Heat Release Rates—Uphol. Furn. Comp. & Mattresses
265 Textile Wall Coverings—Room Fire Growth Contribution, Tests for
266 Uphol. Furn. Exp. to Flaming Ignition Sources, Test for
267 Mattress and Bedding Exp. to Flaming Ignition Source, Test for
268 Ignitibility of Exterior Wall Assemblies, Test for
269 Toxic Potency Data for Fire Hazard Modeling, Test for
291 Fire Hydrants
295 Wildfire Control
297 Communications Systems
298 Foam Chem. for Class A Fuels/Rural Suburban
299 Wildfire, Protection Life and Property from
302 Pleasure and Comm. Motor Craft
303 Marinas and Boatyards
306 Vessels, Gas Hazards on
307 Marine Terminals, Piers, Wharves
312 Vessels, Constr., Repair
318 Cleanrooms
325 Prop. of Flam. Liquids, Gases, Solids
326 Underground Storage Tanks, Safe Entry
327 Cleaning Small Tanks
328 Manholes, Sewers, Flam. Liquids and Gases in
329 Flam. and Com. Liquid, Underground Releases
385 Tank Vehicles
386 Portable Shipping Tanks
395 Farms, Storage Flam. Liquids
402 Aircraft Rescue, Fire Fighting
403 Aircraft Rescue Services
407 Aircraft Fuel Servicing
408 Aircraft Extinguishers
409 Aircraft Hangars
410 Aircraft Maintenance
412 Eval., Foam Equip. for Aircraft
414 Aircraft Rescue Vehicles
415 Aircraft Fueling Ramp Drainage
416 Airport Terminals
417 Aircraft Loading Walkways
418 Heliports
422 Aircraft Accident Response
423 Aircraft Engine Test Facilities
424 Airport/Community Emerg. Planning
430 Liquid/Solid Oxidizers
471 Responding to Haz. Mat. Incidents
472 Haz. Mat. Resp. Prof. Comp.
473 Competencies for EMS Personnel
480 Magnesium
481 Titanium
482 Zirconium
485 Lithium Metal
490 Ammonium Nitrate
491M Haz. Chem. Reactions
495 Explosive Materials
496 Purged Enclosures, Elec. Equip.
497A Class I Haz. Locations for Elec. Inst.
497B Class II Haz. Locations for Elec. Inst. in Chem. Process Areas
497M Gases, Vapors Dusts for Elec. Equip. in Haz. Loc.
498 Explosives Motor Vehicle Term.
501A Manufactured Home Instal., Sites
501C Recreational Vehicles
501D Recreational Vehicle Parks
502 Highways, Tunnels, Bridges
505 Powered Industrial Trucks
512 Truck Fire Protection
513 Motor Freight Terminals
550 Fire Safety Concepts Tree
555 Evaluating Potential for Room Flashover
560 Ethylene Oxide
600 Industrial Fire Brigades
601 Guard Service
650 Pneumatic Conveying Systems
651 Aluminum Powder
654 Chemical, Dye, Pharm., and Plastics Indust.
655 Sulfur Fires and Explosions
664 Wood Processing, Woodworking
701 Textiles, Films, Fire Tests
703 Fire-Ret. Treat. of Bldg. Mat'ls.
704 Fire Hazards of Materials
705 Field Flame Test for Textiles and Films
750 Water Mist Fire Protection Systems
780 Lightning Protection Systems
801 Radioactive Materials Facilities
802 Nuclear Research Reactors
803 Light Water Nuclear Power Plants
804 Adv. Light Water Reactor Electric Generating Plants
820 Wastewater Facilities
850 Electric Generating Plants
851 Hydroelectric Generating Plants
901 Incident Reporting, Fire Prot. Data
902M Field Incident Manual
903 Property Survey Guide
904 Incident Follow-up Report Guide
906 Fire Incident Field Notes
910 Libraries and Library Collections
911 Museums and Museum Collections
912 Places of Worship
914 Fire Prot. in Historic Struc.
921 Fire and Explosion Investigations
1000 Prof. Qual. Accreditation and Cert. Sys.
1001 Fire Fighter Prof Qual.
1002 F.D. Vehicle Driver Prof. Qual.
1003 Airport Fire Fighter Prof. Qual.
1021 Fire Officer Prof. Qual.
1031 Fire Inspector Prof. Qual.
1033 Fire Investigator Prof. Qual.
1035 Public Fire Educator Prof. Qual.
1041 Fire Instructor Prof. Qual.
1051 Wildland Fire Fighter Prof. Qual.
1061 Public Safety Telecommunicator Prof. Qual
1122 Model Rocketry
1123 Fireworks Display
1124 Fireworks, Mfg., Trans., Stge
1125 Model Rocket/High Power Rocket Motors, Mfg.
1126 Pyrotechnics Before Proximate Audience
1127 High Power Rocketry
1141 Planned Building Groups
1201 Devel. of FP Services for Public
1221 Public Fire Serv. Comm. Systs.
1231 Suburban & Rural Water Supplies
1401 Training Reports, Records
1402 Building Training Centers
1403 Live Fire Training Evolutions
1404 FD SCBA Program
1405 Land-Based Fire Fighters Who Respond to Marine Vessel Fires
1406 Outside Live Fire Training Evolutions
1410 Initial Fire Attack
1420 Warehouse Occupancies
1452 Dwelling Fire Safety Surveys
1470 Search and Rescue, Struct. Collapse
1500 Fire Dept. Occupational Safety and Health Prog.
1521 Fire Dept. Safety Officer
1561 F.D. Incident Management Syst.
1581 F.D. Infection Control Program
1582 Medical Requirements for Fire Fighters
1600 Disaster Management
1901 Automotive Fire Apparatus
1906 Wildland Fire Apparatus
1911 Pumps on F.D. Apparatus, Tests of
1914 F.D Aerial Devices, Testing
1921 Portable Pumping Units
1922 Self-Contained Pumping Units
1931 Fire Dept. Ground Ladders, Design
1932 Fire Dept. Ground Ladders, Use
1961 Fire Hose
1962 Fire Hose Care, Use
1963 Fire Hose Connections
1964 Spray Nozzles (Shutoff and Tip)
1971 Prot. Clothing, Structural Fire Fighting
1972 Helmets, Structural Fire Fighting
1973 Gloves, Structural Fire Fighting
1974 Prot. Footwear, Struc. Fire Fighting
1975 Station/Work Uniforms for FF
1976 Prot. Clothing - Proximity Fire Fighting
1977 Prot. Clothing - Wildland Fire Fighting
1981 Self-Contained Breathing App.
1982 Personal Alert Safety Systems for Fire Fighters
1983 Life Safety Rope and Sys. Comp.
1991 Vapor-Protective Suits for Haz. Chem. Emergencies
1992 Liquid Splash-Protective Suits for Haz. Chem. Emergencies
1993 Support Function Prot. Clothing for Haz. Chem. Oper.
1999 Prot. Clothing - Medical Emerg. Oper.
2001 Clean Agent Ext. Systems
8501 Single Burner Boiler Operation
8502 Furnace Explosions/Implosions in Multiple Boilers
8503 Pulverized Fuel Systems
8504 Atmospheric Fluidized-Bed Boiler Operation
8505 Stoker Operation
8506 Heat Recovery Steam Generators

National Fire Protection Association Membership

When you join NFPA, you join more than 66,000 fire protection professionals worldwide in the fight against loss of life and property from fire.

There are many membership benefits, including full voting rights in the code-making process at the Annual and Fall meetings, free subscriptions to the NFPA *Journal*®, NFPA *Journal Buyers' Guide* and *Fire News* newsletter, a 10% discount on all NFPA products and services including videos, seminars, and meeting registration fees and much more!

Join today by calling 1-800-344-3555 and become an active leader in the fire protection industry.

Other Fire Protection Resources from NFPA

Automatic Sprinkler Systems Handbook

Just revised and expanded, the 1996 *Automatic Sprinkler Systems Handbook* is the indispensable guide to interpreting and applying the sprinkler standards. It includes the entire texts of the most recent editions of NFPA 13, 13D, and 13R. It explains the philosophy and history behind requirements – including the latest revisions – so you gain a full understanding of why and how to apply provisions correctly.

Automatic Sprinkler Systems Seminar

At this exclusive NFPA seminar, you learn directly from the experts who work with sprinkler systems standards. You can discuss specific problems and issues one-on-one with instructors. You'll gain the training you need to avoid mistakes, determine compliance of sprinkler designs and installations, understand various design approaches, and learn about proper system inspection, testing, and maintenance criteria.

NFPA 25: Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems

This informative document provides instruction on how to conduct inspections, tests, and maintenance activities to help ensure the successful operation of water-based fire protection systems. Requirements are provided for impairment procedures, notification processes, and system restoration.

For ordering information or to sign up for any of our seminars, call toll-free at 1-800-344-3555.