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NFPA 25 Water-Based Fire Protection Systems 1992 Edition

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The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

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NFPA 25

Standard for the

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

1992 Edition

This edition of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, was prepared by the Technical Committee on Inspection, Testing and Maintenance of Water-Based Extinguishing Systems, released by the Correlating Committee on Water Extinguishing Systems, and acted on by the National Fire Protection Association, Inc. at its Fall Meeting held November 18-20, 1991 in Montréal, Québec, Canada. It was issued by the Standards Council on January 17, 1992, with an effective date of February 10, 1992.

The 1992 edition of this document has been approved by the American National Standards Institute.

Origin and Development of NFPA 25

This first edition of NFPA 25 represents a collection of inspection, testing, and maintenance features that will help ensure the successful operation of water-based fire protection systems. NFPA 25 is a continuation of existing documents such as NFPA 13A, *Recommended Practice for the Inspection, Testing and Maintenance of Sprinkler Systems*, and NFPA 14A, *Recommended Practice for the Inspection, Testing, and Maintenance of Standpipe and Hose Systems*, which have successfully assisted authorities having jurisdiction and building owners with routine inspections of sprinkler systems and standpipes. It is also an expansion of those documents in that it governs other systems as well, including underground piping, fire pumps, storage tanks, water spray systems, and foam-water sprinkler systems.

This document provides instruction on how to conduct inspection, test, and maintenance activities. It also stipulates how often such activities must be completed. Requirements are provided for impairment procedures, notification processes, and system restoration. This type of information, when incorporated into a building maintenance program, will enhance the already favorable experience of all water-based fire protection systems.

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NOTE: Membership on a Committee shall not in and of itself constitute an endorsement of the Association or any document developed by the Committee on which the member serves.

Contents

NOTE: Individual chapters are devoted to the requirements for inspection, testing, and maintenance of each specific type of water-based extinguishing system or subsystem as indicated in the Table of Contents. Valves are treated separately in Chapter 9 because of their use in all such systems or subsystems.

NFPA 25

Standard for the

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

1992 Edition

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A.

Information on referenced publications can be found in Chapter 11 and Appendix C.

Chapter 1 General Information

1-1 Scope. This document establishes the minimum requirements necessary for the periodic inspection, testing, and maintenance of water-based fire protection systems. The types of systems addressed by this standard include but are not limited to sprinkler, standpipe and hose, fixed water spray, and foam water. Included are the water supplies that are part of these systems such as private fire service mains and appurtenances, fire pumps and water storage tanks, as well as valves controlling system flow. The document also addresses impairment handling and reporting. This standard applies to fire protection systems that have been properly installed in accordance with generally accepted practices. When a system has not been installed in accordance with generally accepted practices, it may be that corrective action beyond the requirements of this standard will be needed in order to ensure that the system will be able to perform in a satisfactory manner.

1-2* Purpose. The purpose of this document is to provide requirements that ensure a reasonable degree of protection for life and property from fire through minimum inspection, testing, and maintenance methods for water-based fire protection systems.

1-2.1* Application. It is not the intent of this document to limit or restrict the use of other inspection, testing, or maintenance programs that provide an equivalent level of system integrity and performance as those detailed in this document. The authority having jurisdiction shall be consulted and approval obtained for such alternative programs.

1-3 Water-Based Fire Protection System Descriptions.

1-3.1 Sprinkler System. For fire protection purposes, an integrated system of underground and overhead piping designed in accordance with fire protection engineering standards. The installation includes one or more automatic water supplies. The portion of the sprinkler system aboveground is a network of specially sized or hydraulically designed piping installed in a building, structure, or area, generally overhead, and to which sprinklers are attached in a systematic pattern. The valve controlling each system riser is located in the system riser or its supply piping. Each sprinkler system riser includes a device for actuating an alarm when the system is in operation. The system is usually activated by heat from a fire and discharges water over the fire area.

Wet Pipe System. A sprinkler system employing automatic sprinklers attached to a piping system containing water and connected to a water supply so that water discharges immediately from sprinklers opened by heat from a fire. (*See Chapters 2 and 9.*)

Antifreeze System. A wet pipe sprinkler system employing automatic sprinklers attached to a piping system containing an antifreeze solution and connected to a water supply. The antifreeze solution is discharged, followed by water, immediately upon operation of sprinklers opened by heat from a fire. (*See Chapters 2 and 9.*)

Dry Pipe System. A system employing automatic sprinklers attached to a piping system containing air or nitrogen under pressure, the release of which (as from the opening of a sprinkler) permits the water pressure to open a valve known as a dry pipe valve. The water then flows into the piping system and out the opened sprinklers. (*See Chapters 2 and 9.*)

Deluge System. A system employing open sprinklers attached to a piping system and connected to a water supply through a valve that is opened by the operation of a detection system installed in the same areas as the sprinklers. When this valve opens, water flows into the piping system and discharges from all sprinklers attached thereto. (*See Chapters 2, 7, 8, and 9.*)

Preaction System. A sprinkler system employing automatic sprinklers attached to a piping system containing air that may or may not be under pressure, with a supplemental detection system installed in the same areas as the sprinklers. Actuating means of the valve are described in 3-3.2.1 of NFPA 13, *Standard for the Installation of Sprinkler Systems.* Actuation of the detection system opens a valve that permits water to flow into the sprinkler piping system and to be discharged from any sprinklers that may be open. (*See Chapters 2 and 9.*)

Combined Dry Pipe-Preaction System. A sprinkler system employing automatic sprinklers attached to a piping system containing air under pressure with a supplemental detection system installed in the same areas as the sprinklers. Operation of the detection system actuates tripping devices that open dry pipe valves simultaneously and without loss of air pressure in the system. Operation of the detection system also opens listed air exhaust valves at the end of the feed main, which usually precedes the opening of sprinklers. The detection system also serves as an automatic fire alarm system. (*See Chapters 2 and 9.*)

1-3.2 Standpipe System. An arrangement of piping, valves, hose connections, and allied equipment installed in a building or structure with the hose connections located in such a manner that water can be discharged in streams or spray patterns through attached hose and nozzles for the purpose of extinguishing a fire, thus protecting a building or structure and its contents in addition to protecting the

occupants. This is accomplished by connections to water supply systems or by pumps, tanks, and other equipment necessary to provide an adequate supply of water to the hose connections. (*See Chapter 3.*)

Wet Standpipe System. A system that has the supply valve open and the water pressure maintained at all times.

Dry Standpipe System. A system that shall be arranged as follows:

(a) Includes devices to admit water to the system automatically by opening a hose valve.

(b) Admits water to the system through manual operation of remote control devices located at each hose station.

(c) Has no permanent water supply. A filled standpipe having a small water supply connection to keep the piping filled by requiring water to be pumped into the system shall be considered a dry standpipe of this type.

1-3.3 Combined Standpipe and Sprinkler System. A system where the water piping services both 2½-in. (63.5-mm) outlets for fire department use and outlets for automatic sprinklers. (*See Chapters 2 and 3.*)

1-3.4 Private Fire Service Main. That pipe and its appurtenances on private property between a source of water and the base of the riser (flange or flange and spigot piece or base tee) for automatic sprinkler systems, open sprinkler systems, water spray fixed systems, standpipe systems, inlets to foam-making systems, or the base elbow of private hydrants or monitor nozzles. When connected to a public water system, the private service main begins at a point designated by the public water utility, usually at a manually operated valve near the property line. When connected to fire pumps, the main begins at the fire protection system side of the pump discharge valve. When connected to a gravity or pressure tank, the main begins at the inlet side of the tank's check valve. (*See Chapter 4.*)

Private fire service mains can include supply and distribution piping installed above ground, in trenches, and inside or outside of buildings. The provisions of this section also apply to pipeline strainers.

1-3.5 Fire Pump. A pump supplying water at the flow and pressure required by water-based fire protection systems. (*See Chapter 5.*)

1-3.6 Water Tank. A tank supplying water for water-based fire protection systems. (*See Chapter 6.*)

1-3.7 Water Spray Fixed System. A special fixed pipe system connected to a reliable fire protection water supply and equipped with water spray nozzles for specific water discharge and distribution over the surface or area to be protected. The piping system is connected to the water supply through an automatically or manually actuated valve that initiates the flow of water. An automatic valve is actuated by operation of automatic detection equipment installed in the same areas as the water spray nozzles. (In special cases the automatic detection equipment may also be located in another area.) (*See Chapter 7.*)

1-3.8 Deluge Foam-Water Sprinkler and Foam-Water Spray Systems.

1-3.8.1 Foam-Water Spray System. A special system pipe-connected to a source of foam concentrate and to a water supply and equipped with foam-water spray nozzles for fire protection-agent discharge (foam and water sequentially in that order or in reverse order) and distribution over the area to be protected. System operation arrangements parallel those for foam-water sprinkler systems as described in 1-3.8.2.

1-3.8.2 Foam-Water Sprinkler System. A special system pipe-connected to a source of foam concentrates and to a water supply and equipped with appropriate discharge devices for fire protection agent discharge and for distribution over the area to be protected. The piping system is connected to the water supply through a control valve that is usually actuated by operation of automatic detection equipment installed in the same areas as the sprinklers. When this valve opens, water flows into the piping system and foam concentrate is injected into the water. The resulting foam solution discharging through the discharge devices generates and distributes foam. Upon exhaustion of the foam concentrate supply, water discharge will follow the foam and continue until shut off manually. Systems may also be used for discharge of water first, followed by discharge of foam for a definite period and then followed by water until manually shut off. Existing deluge sprinkler systems that have been converted to the use of aqueous film forming foam are classed as foam-water sprinkler systems. (*See Chapter 8.*)

1-3.9* Control Valves. A valve that controls the flow of water to a water-based fire protection system. For procedures concerning control valves, see Chapter 9.

1-4 Responsibility of the Owner or Occupant.

1-4.1* The responsibility for properly maintaining a water-based fire protection system shall be the obligation of the owners of the property. By means of periodic inspections, tests, and maintenance, the equipment shall be shown to be in good operating condition or any defects or impairments shall be revealed.

These activities — inspection, testing, and maintenance — shall be implemented in accordance with procedures meeting or exceeding those established in this document and in accordance with the manufacturer's instructions. These tasks shall be performed by personnel who have developed competence through training and experience.

1-4.2 The owner or occupant shall notify the authority having jurisdiction, the fire department, if required, and the alarm receiving facility before shutting down a system or its supply. The notification shall include the purpose for the shutdown, the system or component involved, and the estimated time required. The authority having jurisdiction, the fire department, and the alarm receiving facility shall be notified when the system, supply, or component is returned to service.

1-4.3 The owner or occupant shall promptly correct or repair deficiencies, damaged parts, or impairments found while performing the inspection, test, and maintenance

requirements of this standard. Corrections and repairs shall be performed by qualified maintenance personnel or a qualified contractor.

1-4.4* The owner or occupant shall give special attention to factors that might alter the requirements for a continued satisfactory or acceptable installation. Such factors shall include but are not limited to:

(a) Occupancy changes such as revising office or production space to warehousing.

(b) Process or material changes such as metal stamping to molded plastics.

(c) Building revisions such as relocated walls, added mezzanines, and ceilings added below sprinklers.

(d) Removal of heating systems in spaces with piping subject to freezing.

1-4.5 Where changes in the occupancy, hazard, water supply, storage commodity, storage arrangement, building modification, or other conditions that affect the installation criteria of the system are identified, the owner or occupant shall promptly take steps to evaluate the adequacy of the installed system to protect the building or hazard in question, such as contacting a qualified contractor, consultant, or engineer. Where the evaluation reveals a deficiency, the owner shall notify the insurance underwriter, the authority having jurisdiction, and the local fire department.

1-4.6 Where a water-based fire protection system is returned to service following an impairment, it shall be verified that it is working properly. The appropriate NFPA standard (*see Chapter 11*) shall be referenced to provide guidance on the type of inspection or test, or both, required.

1-5 Definitions.

Alarm Receiving Facility. The point where alarm or supervisory signals are received. This may include proprietary or remote locations, central station, or fire departments.

Approved. Acceptable to the "authority having jurisdiction."

NOTE: The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment, or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment and installation or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner, since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, electrical inspector or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau or other insurance company representative may be the "authority having jurisdiction." In many circumstances the property owner or his designated agent assumes the role of the "authority having jurisdiction;" at government installations, the commanding officer or departmental official may be the "authority having jurisdiction."

Automatic Fire Detector. A device that detects abnormally high temperature, rate of temperature rise, visible or invisible particles, infrared or visible radiation, or gases produced by a fire.

Automatic Operation. Operates without human intervention. This operation includes but is not limited to heat, rate of heat rise, smoke, or pressure change.

Discharge Device. A device designed to discharge water or water-foam solution in a predetermined, fixed, or adjustable pattern. Examples include but are not limited to sprinklers, spray nozzles, and hose nozzles.

Double Check Valve Assembly (DCVA). This assembly consists of two internally loaded check valves, either spring-loaded or internally weighted, installed as a unit between two tightly closing resilient-seated shutoff valves as an assembly, and fittings with properly located resilient-seated test cocks.

Fire Department Connection. A connection through which the fire department can pump supplemental water into the sprinkler system, standpipe, or other system furnishing water for fire extinguishment to supplement existing water supplies.

Foam Concentrate. A liquid stored in a containment vessel that is metered into a flowing water stream at a specified concentration by the proportioning system.

Impairment. A shutdown of a system or portion thereof. The two types of impairments are:

Emergency. A condition wherein a water-based fire protection system or portion thereof is out of order due to an unexpected occurrence, such as a ruptured pipe, operated sprinkler, or interruption of water supply to the system.

Pre-Planned. A condition wherein a water-based fire protection system or a portion thereof is out of service due to work that has been planned in advance, such as revisions to the water supply or sprinkler system piping.

Inspection. A visual examination of a water-based fire protection system or portion thereof to verify that it appears to be in operating condition and is free of physical damage.

Inspection, Testing, Maintenance Service. A service program provided by a qualified contractor or owner's representative in which all components unique to the property's systems are inspected and tested at the required times and necessary maintenance is provided. This program includes logging and retention of relevant records.

Listed. Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The "authority having jurisdiction" should utilize the system employed by the listing organization to identify a listed product.

Maintenance. Work performed to keep equipment operable or to make repairs.

Manual Operation. Operation of a system or its components through human action.

Qualified. Having adequate knowledge of the installation, construction, or operation of apparatus and the hazards involved.

Reduced-Pressure Principle Backflow-Prevention Assembly (RPBA). Consists of two independently acting check valves together with a hydraulically operating, mechanically independent pressure differential relief valve located between the check valves and below the first check valve. These units are located between two tightly closing resilient-seated shutoff valves, as an assembly, and are equipped with properly located resilient-seated test cocks.

Shall. Indicates a mandatory requirement.

Should. Indicates a recommendation or that which is advised but not required.

Standard. A document containing only mandatory provisions using the word "shall" to indicate requirements. Explanatory material may be included only in the form of "fine print" notes, in footnotes, or in an appendix.

Supervision. A means of monitoring system status and indicating abnormal conditions.

Testing. A procedure to determine the status of a system as intended by conducting periodic physical checks on water-based fire protection systems such as waterflow tests, fire pump tests, alarm tests, and trip tests of dry pipe, deluge, or preaction valves. These tests follow up on the original acceptance test at intervals specified in the appropriate chapter of this standard.

Water Supply. A source of water that will provide the flows (gpm) and pressures (psi) required by the water-based fire protection system.

1-6 Units. Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). Two units (liter and bar), outside of but recognized by SI, are commonly used in international fire protection. These units are listed in Table 1-6 with conversion factors.

Table 1-6 Metric Conversions

Name of Unit	Unit Symbol	Conversion Factor
liter	L	1 gal = 3.785 L
liter per minute per square meter	$(L/min)/m^2$	1 gpm/ft^2 = 40.746 $(L/min)\ m^2$
cubic decimeter	dm^3	1 gal = 3.785 dm^3
Pascal	Pa	1 psi = 6894.757 Pa
bar	bar	1 psi = 0.0689 bar
bar	bar	1 bar = 10^5 Pa

For additional conversions and information, see ASTM E380-1979, *Standard for Metric Practice.*

1-6.1 If a value for measurement as given in this standard is followed by an equivalent value in other units, the first stated shall be regarded as the requirement. A given equivalent value may be approximate.

1-6.2 The conversion procedure for the SI units has been to multiply the quantity by the conversion factor and round the result to the appropriate number of significant digits.

1-7 Impairments. When an impairment to a water-based fire protection system occurs, the procedures outlined in Chapter 10 of this standard shall be followed, including the attachment of a tag to the impaired system. The local fire department, if required, and other authorities having jurisdiction shall be notified when a system is impaired and when the system is returned to service.

1-8* Records. Records of inspections, tests, and maintenance of the system and its components shall be retained by the owner. Typical records include but are not limited to valve inspections; flow, drain, and pump tests; and trip tests of dry pipe, deluge, and preaction valves.

1-9 Inspection.

1-9.1* System components shall be inspected at intervals listed in the following chapters.

1-9.2 Inspection and periodic testing determines what, if any, maintenance actions are required to maintain the operability of a water-based fire protection system. The standard establishes minimum inspection/testing frequencies, responsibilities, test routines, and reporting procedures but does not define exact limits of anomalies when maintenance actions are required.

1-10 Testing.

1-10.1 All components and systems shall be tested to verify that they function as intended. Frequency of tests shall be in accordance with those required by the chapters listed in 1-9.1. Following tests of components or portions of water fire protection systems that require valves to be opened or closed, the system shall be returned to service with verification that all valves are restored to their normal operating position. Plugs or caps for auxiliary drains or test valves shall be replaced.

1-10.1.1 Test results shall be compared with those of the original acceptance test (if available) and with the most recent test results.

1-10.2 The types of tests required for each protection system and its components are detailed in the appropriate chapter.

1-10.3 Specialized equipment required for testing is defined in the appropriate chapter.

1-11 Maintenance.

1-11.1 Maintenance shall be performed to keep the system equipment operable or to make repairs. As-built system installation drawings, original acceptance test records, and device manufacturer's maintenance bulletins shall be retained to assist in proper care of the system and its components.

1-11.2 Preventive maintenance includes but is not limited to lubricating control valve stems, adjusting packing glands on valves and pumps, bleeding moisture and condensation from air compressors, air lines, and dry pipe system auxiliary drains, and cleaning strainers. Frequency of maintenance is indicated in the appropriate chapter. (*See 1-9.1.*)

1-11.3 Corrective maintenance includes but is not limited to replacing loaded, corroded, or painted sprinklers, replacing missing or loose pipe hangers, cleaning clogged fire pump impellers, replacing valve seats and gaskets, restoring heat in areas subject to freezing temperatures where water-filled piping is installed, and replacing worn or missing fire hose or nozzles.

1-11.4 Emergency maintenance includes but is not limited to repairs due to piping failures caused by freezing or impact damage, repairs to broken underground fire mains, and replacing frozen or fused sprinklers, defective electric power, or alarm and detection system wiring.

1-12 Safety. Inspection, testing, and maintenance activities shall be conducted in a safe manner.

1-12.1 Confined Spaces. Appropriate and legally required precautions shall be taken prior to entering confined spaces, such as tanks, valve pits, or trenches.

1-12.2 Fall Protection. Appropriate and legally required equipment shall be worn or used to prevent injury to personnel from falls.

1-12.3 Special Hazards. Precautions shall be taken to address any special hazards, such as protection against drowning when working on the top of a filled embankment, supported, rubberized fabric tank, or over open water or other liquids.

1-12.4* Hazardous Materials. Any person performing inspection, testing, or maintenance on any system covered within the scope of this document shall check with the owner or owner's representative to have full knowledge of hazardous materials being used or stored on the premises. Appropriate and legally required equipment shall be used when working in an environment with hazardous materials present.

Chapter 2 Sprinkler Systems

2-1 General Information. This chapter provides the minimum requirements relative to the routine inspection, testing, and maintenance of sprinkler systems. Table 2-1 (see following page) shall be used to determine the minimum required frequencies for inspection, testing, and maintenance.

Exception: Requirements for valves and fire department connections are in Chapter 9.

2-1.1 Impairments. The inspection, testing, and maintenance of the automatic sprinkler systems may involve or result in a system being out of service. The procedures outlined in Chapter 10 of this standard shall be followed when such an impairment to protection occurs.

2-1.2 Notification to Supervisory Service. To avoid false alarms where a supervisory service is provided, the alarm receiving facility shall always be notified by the owner or designated representative (1) before conducting any test or procedure that could result in the activation of an alarm, and (2) after such tests or procedures are completed.

2-1.3 Control Valves. All control valves involved with sprinkler systems shall be inspected at the following intervals:

(a) Sealed valves — weekly.

(b) Locked valves and valves with tamper switches — monthly.

Valves shall be maintained in accordance with Chapter 9.

2-1.4 Records. Records shall be maintained in accordance with Section 1-8.

Table 2-1
Summary of Minimum Inspection, Testing, and Maintenance

Item	Activity	Frequency	Section Number
Gauges (dry, pre-action deluge systems)	Inspection	Weekly/Monthly	2-2.4.2
Control Valves	Inspection	Weekly/Monthly	See Table 9-1
Alarm Devices	Inspection	Monthly	2-2.6
Gauges (wet pipe systems)	Inspection	Monthly	2-2.4.1
Hydraulic Nameplate	Inspection	Quarterly	2-2.7
Buildings	Inspection	Annually (prior to freezing weather)	2-2.5
Hanger/Seismic Bracing	Inspection	Annually	2-2.3
Piping	Inspection	Annually	2-2.2
Sprinklers	Inspection	Annually	2-2.1.1
Fire Department Connections	Inspection		See Table 9-1
Valves (all types)	Inspection		See Table 9-1
Alarm Devices	Test	Quarterly	2-3.3
Main Drain	Test	Quarterly	Table 9-1
Antifreeze Solution	Test	Annually	2-3.4
Gauges	Test	5 years	2-3.2
Sprinklers—High Temp.	Test	5 years	2-3.1.1 Exception 3
Sprinklers—Fast Response	Test	20 years and every 10 years thereafter	2-3.1.1 Exception 2
Sprinkler	Test	50 years and every 10 years thereafter	2-3.1.1
Valves (all types)	Maintenance	Annually or as needed	See Table 9-1
Obstruction Investigation	Maintenance	5 years or as needed	2-4.3

2-2 Inspection.

2-2.1 Sprinklers.

2-2.1.1* Sprinklers shall be visually inspected from floor level annually. Sprinklers shall be free of corrosion, obstructions to spray patterns, foreign materials, paint, and physical damage. Any automatic sprinklers shall be replaced that are painted, corroded, damaged, or loaded with foreign materials.

Exception: Sprinklers installed in concealed spaces or crawl spaces that are inaccessible.*

2-2.1.2 The supply of spare sprinklers shall be inspected monthly for the following:

(a) The proper number and type of sprinklers.

(b) A sprinkler wrench for each type of sprinkler.

2-2.2* Piping. Sprinkler piping shall be inspected annually to verify that it is in good condition and free of mechanical damage, leakage, corrosion, and misalignment. Sprinkler piping shall not be subjected to external loads.

Exception: Sprinkler piping located in concealed spaces such as above a drop ceiling.*

2-2.3* Hangers and Seismic Braces. Sprinkler pipe hangers and seismic braces shall be inspected annually. Damaged or loose hangers and braces shall be replaced or refastened.

Exception: Sprinkler hangers located in concealed spaces such as above a drop ceiling.*

2-2.4 Gauges.

2-2.4.1* Gauges on wet pipe sprinkler systems shall be inspected monthly to ensure that they are in good condition and that normal water supply pressure is being maintained.

2-2.4.2 Gauges on dry, preaction, and deluge systems shall be inspected weekly to ensure that normal air and water pressures are being maintained.

Exception: Where air pressure supervision is connected to a constantly attended location, gauges shall be inspected at least monthly.

2-2.5 Buildings. Annually, prior to the onset of freezing weather, buildings shall be inspected to verify that windows, skylights, doors, ventilators, other openings and closures, blind spaces, unused attics, stair towers, roof houses, and low spaces under buildings will not expose sprinkler piping to freezing and that adequate heat [minimum 40°F (4.4°C)] is available.

2-2.6 Alarm Devices. Alarm devices shall be inspected monthly to verify that they are free of physical damage and that all electrical connections are secure.

2-2.7* Hydraulic Nameplate. The hydraulic nameplate, if provided, shall be inspected quarterly to verify that it is securely attached to the sprinkler riser and is legible.

2-3 Testing.

2-3.1 Sprinklers.

2-3.1.1 Where sprinklers have been in service for 50 years, they shall be replaced or representative samples shall be submitted to a recognized testing laboratory acceptable to the authority having jurisdiction for operational testing. Test procedures shall be repeated thereafter at 10-year intervals.

Exception No. 1: Sprinklers manufactured prior to 1920 shall be replaced.

Exception No. 2: Fast response sprinklers that have been in service for 20 years shall be tested. They shall be retested at 10-year intervals.

Exception No. 3: Representative samples of solder-type sprinklers with temperature classification of Extra High [325°F (163°C)] or greater that are exposed to semicontinuous to continuous maximum allowable ambient temperature conditions shall be tested at 5-year intervals.*

2-3.1.2 A representative sample of sprinklers shall consist of a minimum of two per floor or individual riser, and in any case not less than four, or 1 percent of the number of sprinklers per individual sprinkler system, whichever is greater.

2-3.1.3 Where representative samples fail to meet the test requirements, all sprinklers that sample represents shall be replaced. (*See 2-4.1.1.*)

2-3.2* Gauges. Gauges shall be replaced every 5 years or tested every 5 years by comparison with a calibrated gauge. Gauges not accurate to within 3 percent of the full scale shall be recalibrated or replaced.

2-3.3* Alarm Devices. Waterflow alarm devices including but not limited to mechanical water motor gongs, vane-type waterflow devices, and pressure switches that provide audible or visual signals shall be tested quarterly.

2-3.3.1* Testing the waterflow alarm on wet pipe systems shall be accomplished by opening the inspector's test connection.

Exception: When freezing weather conditions or other circumstances prohibit use of the inspector's test connection, the bypass connection shall be permitted to be used.

2-3.3.2* Testing the waterflow alarm on dry pipe, preaction, or deluge systems shall be accomplished by using the bypass connection.

2-3.4* Antifreeze Systems. The freezing point of solutions in antifreeze shall be tested annually by measuring the specific gravity with a hydrometer or refractometer and adjusting the solutions if necessary. Solutions shall be in accordance with Tables 2-3.4(a) and (b).

The use of antifreeze solutions shall be in accordance with any state or local health regulations. [*See Table 2-3.4(b).*]

Table 2-3.4(a) Antifreeze Solutions to Be Used if Nonpotable Water Is Connected to Sprinklers

Material	Solution (by volume)	Specific Gravity at 60°F (15.6°C)	Freezing Point °F	°C
Glycerine	If glycerine is used, see Table 2-3.4(b)			
Diethylene	50% Water	1.078	−13	−25.0
Glycol	45% Water	1.081	−27	−32.8
	40% Water	1.086	−42	−41.1
	Hydrometer Scale 1.000 to 1.120 (Subdivisions 0.002)			
Ethylene	61% Water	1.056	−10	−23.3
Glycol	56% Water	1.063	−20	−28.9
	51% Water	1.069	−30	−34.4
	47% Water	1.073	−40	−40.0
	Hydrometer Scale 1.000 to 1.120 (Subdivisions 0.002)			
Propylene Glycol	If propylene glycol is used, see Table 2-3.4(b)			
Caclium Chloride 80% "Flake"	lb $CaCl_2$ per gal of Water			
Fire Protection Grade*				
Add corrosion	2.83	1.183	0	−17.8
inhibitor	3.38	1.212	−10	−23.3
of sodium	3.89	1.237	−20	−28.9
bichromate	4.37	1.258	−30	−34.4
¾ oz per gal	4.73	1.274	−40	−40.0
water	4.93	1.283	−50	−45.6

*Free from magnesium chloride and other impurities.

Table 2-3.4(b) Antifreeze Solutions to Be Used if Potable Water Is Connected to Sprinklers

Material	Solution (by volume)	Specific Gravity at 60°F (15.6°C)	Freezing Point °F	°C
Glycerine	50% Water	1.133	−15	−26.1
C.P. or U.S.P.	40% Water	1.151	−22	−30.0
Grade*	30% Water	1.165	−40	−40.0
	Hydrometer Scale 1.000 to 1.200			
Propylene	70% Water	1.027	+9	−12.8
Glycol	60% Water	1.034	−6	−21.1
	50% Water	1.041	−26	−32.2
	40% Water	1.045	−60	−51.1
	Hydrometer Scale 1.000 to 1.200 (Subdivisions 0.002)			

*C.P.—Chemically Pure.
U.S.P.—United States Pharmacopia 96.9%.

2-4 Maintenance.

2-4.1 Sprinklers.

2-4.1.1* Replacement sprinklers shall have the proper characteristics for the application intended. This includes:

(a) Style

(b) Orifice size and K factor

(c) Temperature rating

(d) Coating, if any

(e) Deflector type (upright, pendent, sidewall, etc.)

(f) Design requirements.

Exception No. 1: Spray sprinklers shall be permitted to replace old-style sprinklers.

Exception No. 2: For piers and wharves see NFPA 307, Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves.

2-4.1.2 Only new listed sprinklers shall be used to replace existing sprinklers.

2-4.1.3 Special sprinklers (*see NFPA 13, Standard for the Installation of Sprinkler Systems*) shall be replaced with sprinklers of the same make, model, orifice, size, temperature range and thermal response characteristics, and K factor.

Exception: When the special sprinkler is no longer manufactured, a special sprinkler with comparable performance characteristics shall be installed.

2-4.1.4 A supply of spare sprinklers (never less than six) shall be stored in a cabinet on the premises for replacement purposes. The stock of spare sprinklers shall be proportionally representative of the types and temperature ratings of the system sprinklers. A minimum of two sprinklers of each type and temperature rating installed shall be provided. The cabinet shall be so located that it will not be exposed to moisture, dust, corrosion, or a temperature exceeding 100°F (38°C).

2-4.1.5 The stock of spare sprinklers shall be as follows:

(a) For protected facilities having not over 300 sprinklers — not less than 6 sprinklers.

(b) For protected facilities having 300 to 1,000 sprinklers — not less than 12 sprinklers.

(c) For protected facilities having over 1,000 sprinklers — not less than 24 sprinklers.

2-4.1.6* Special sprinkler wrench(es) shall be provided and kept in the cabinet to be used in the removal and installation of sprinklers. A sprinkler wrench(es) shall be provided for each type of sprinkler installed.

2-4.1.7 Sprinklers protecting spray coating areas shall be protected against overspray residue. Sprinklers subject to overspray accumulations shall be protected using plastic bags having a maximum thickness of 0.003 in. (0.076 mm) or with small paper bags. Coverings shall be replaced when deposits or residue accumulate.

2-4.1.8* Sprinklers shall not be altered in any respect or have any type of ornamentation, paint, or coatings applied after shipment from the place of manufacture.

2-4.1.9 Sprinklers and automatic spray nozzles used for protecting commercial-type cooking equipment and ventilating systems shall be replaced annually.

Exception: Where automatic bulb-type sprinklers or spray nozzles are used and annual examination shows no buildup of grease or other material on the sprinklers or spray nozzles.

2-4.2* Dry Pipe Systems. Dry pipe systems shall be maintained dry at all times.

Exception: During non-freezing weather, a dry pipe system can be left wet if the only other option is to remove the system from service while waiting for parts or during repair activities.

2-4.2.1 Compressors used in conjunction with dry pipe sprinkler systems shall be maintained in accordance with the manufacturer's instructions.

2-4.3* Obstruction Investigation and Prevention.

2-4.3.1* Obstruction Investigation. To ensure that piping remains clear of all obstructive foreign matter, conduct an obstruction investigation for sprinkler system or yard main piping wherever any of the following conditions exist:

(a) Defective intake screens for fire pumps taking suction from open bodies of water.

(b) Discharge of obstructive material during routine water tests.

(c) Foreign materials in fire pumps, in dry pipe valves, or in check valves.

(d) Heavy discoloration of water during drain tests or plugging of inspector's test connection(s).

(e) Plugging of sprinklers.

(f) Plugged piping in sprinkler systems dismantled during building alterations.

(g) Failure to flush yard piping or surrounding public mains following new installations or repairs.

(h) A record of broken public mains in the vicinity.

(i) Abnormally frequent false-tripping of dry pipe valve(s).

(j) A system is returned to service after an extended duration (greater than one year).

(k) There is reason to believe that the sprinkler system contains sodium silicate or its derivatives.

2-4.3.2* Flushing Procedure. If an obstruction investigation carried out in accordance with 2-4.3.1 indicates the presence of sufficient material to obstruct sprinklers, conduct a complete flushing program. The work shall be done by qualified personnel.

2-4.3.3* Obstruction Prevention. Sprinkler systems shall be examined internally for obstructions where conditions exist that could cause obstructed piping. If the condition has not been corrected or the condition is one that could result in obstruction of piping despite any previous flushing procedures that have been performed, the system shall be examined internally for obstructions every 5 years.

Chapter 3 Standpipe and Hose Systems

3-1 General Information. This chapter provides the minimum requirements relative to the routine inspection, testing, and maintenance of standpipe and hose systems. Table 3-1 shall be used to determine the minimum required frequencies for inspection, testing, and maintenance.

Exception: Requirements for valves and fire department connections are in Chapter 9.

3-1.1 Definitions.

Cabinet, Interior. Interior cabinets contain hose rack assemblies, Class I, II, or III fire department valves, fire extinguishers, or various combinations of these.

Table 3-1 Summary of Standpipe Inspection, Testing and Maintenance

Item Activity	Activity	Frequency	Reference
Control Valves	Inspection	Weekly/Monthly	3-2.2, Chapter 9
Hose Valve Outlets	Inspection	Monthly	Table 3-2.3
Piping	Inspection	Monthly	Table 3-2.3
Pressure Reducing Valve	Inspection	See Chapter 9	
Cabinet	Inspection	See NFPA 1962	Table 3-2.3
Hose	Inspection	See NFPA 1962	Table 3-2.3
Hose Nozzle	Inspection	See NFPA 1962	Table 3-2.3
Hose Size Device	Inspection	See NFPA 1962	Table 3-2.3
Hose Nozzle	Test	Monthly	Table 3-2.3
Hose Size Device	Test	Monthly	Table 3-2.3
Alarm Device	Test	Quarterly	3-3.3
Hydrostatic Test	Test	5 Years	Table 3-2.3
Water Supply	Test	5 Years	3-3.1.1
Pressure Reducing Valve	Test	See Chapter 9	3-3.1.3
Hose	Test	See NFPA 1962	
Cabinet	Maintenance	Monthly/As Needed	Table 3-2.3
Hose	Maintenance	Monthly/As Needed	Table 3-2.3
Hose Nozzles	Maintenance	Monthly/As Needed	Table 3-2.3
Hose Size Device	Maintenance	Monthly/As Needed	Table 3-2.3
Hose Valve Outlets	Maintenance	Monthly/As Needed	Table 3-2.3
Hose Valves	Maintenance	Monthly/As Needed	Table 3-2.3
Piping	Maintenance	Monthly/As Needed	Table 3-2.3
Pressure Reducing Valve	Maintenance	See Chapter 9	Table 3-2.3

Hose Storage Devices.

Hose Reel. A circular device used to store hose.

Horizontal Rack. The hose is connected to the valve, then stack folded horizontally to the top of the rack.

Conventional Pin Rack. The hose is folded vertically and attached over the pins.

Semi-Automatic Hose Rack Assembly. The same as the "conventional" pin rack or hose reel except that after the valve is opened, a retaining device holds the hose and water until the last few feet are removed.

Hose Nozzle. A device intended for discharging water for manual suppression or extinguishment of a fire.

Class of Service. Standpipe systems are grouped into three general classes of service for intended use in the extinguishment of fire.

Class I. Class I service provides 2½-in. (63.5-mm) hose connections or 2½-in. (63.5-mm) hose stations supplied from a standpipe or combined riser in order to supply water for use by fire departments and those trained in handling heavy fire streams. No hose is provided.

Class II. Class II service provides 1½-in. (38.1-mm) hose stations supplied from a standpipe, combined riser, or sprinkler system in order to supply water for use primarily by the building occupants or by the fire department during initial response.

Exception: A minimum 1-in. (25.4-mm) hose may be used for Class II service in Light Hazard Occupancies when investigated and listed for this service and when approved by the authority having jurisdiction.

Class III. Class III service provides 1½-in. (38.1-mm) and 2½-in. (63.5-mm) hose connections or 1½-in. (38.1-mm) or 2½-in. (63.5-mm) hose stations supplied from a standpipe or combination riser in order to supply water for use by building occupants and a larger volume of water for use by fire departments and those trained in handling heavy fire streams.

Class I service shall be capable of furnishing the effective fire streams required during the more advanced stages of fire on the inside of buildings or for exposure fire protection.

Class II service shall afford a ready means for the control of incipient fires by the occupants of buildings during working hours and by watch personnel and those present during the nighttime and holidays.

Class III service shall be capable of furnishing Class I as well as Class II service.

Valves. See definitions in Chapter 9.

Hose Valves. See definitions in Chapter 9.

Regulating Valves. See definitions in Chapter 9.

Restricting Valves. See definitions in Chapter 9.

3-1.2 Impairments. The inspection, testing, and maintenance of standpipe and hose systems may involve or result in a system being out of service. The procedures outlined in Chapter 10 of this standard shall be followed when such an impairment to protection occurs.

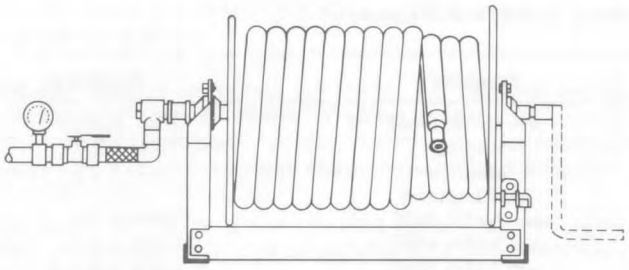


Figure 3-1(a) Constant flow hose reel.

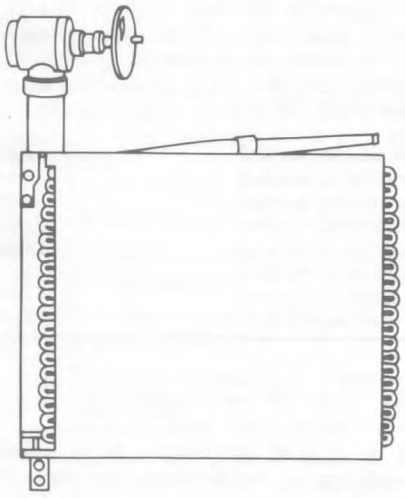


Figure 3-1(b) Horizontal rack.

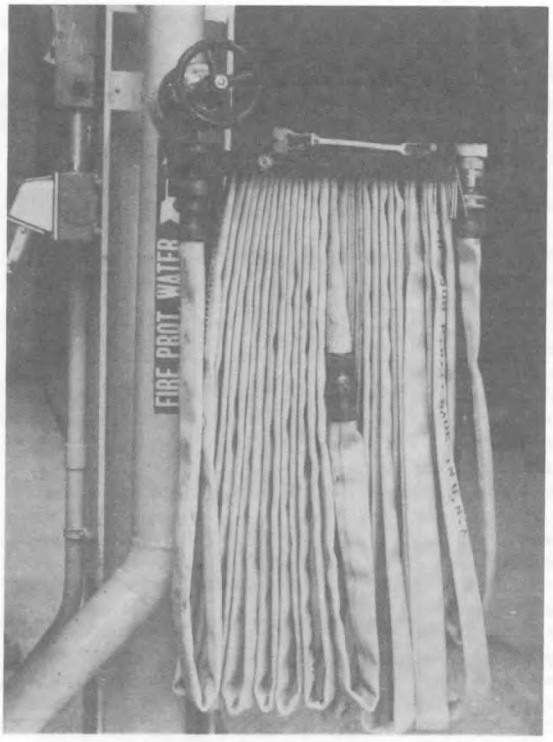


Figure 3-1(c) Conventional pin rack.

Figure 3-1(d) Semi-automatic hose rack assembly.

3-2 Inspection.

3-2.1 Components of standpipe and hose systems shall be visually inspected monthly or as indicated in Table 3-2.3 to determine they are free of corrosion, foreign material, physical damage, tampering, or other conditions that would prevent operation. (*See 3-2.3.*)

3-2.2 All control valves of the standpipe system shall be inspected at regular intervals.

(a) Sealed valves — weekly.

(b) Locked valves and valves with tamper switches — monthly.

Valves shall be maintained as mandated in Chapter 9.

3-2.3 Table 3-2.3 shall be used for the inspection, testing, and maintenance of all classes of standpipe and hose systems.

3-3 Testing. The tests shall be conducted by a qualified person. See Chapter 1.

Where water damage is a possibility, an air test shall be conducted on the system at 25 psi (1.7 bars) prior to introducing water to the system.

3-3.1 Flow Tests.

3-3.1.1 A flow test shall be conducted by flowing the required volume of water at the design pressures to the hydraulically most remote, highest, or dead-end hose connection of each zone of a standpipe system. When a flow test of the hydraulically most remote outlet is not practical, the authority having jurisdiction shall be consulted for the appropriate location of the test. All systems shall be tested at the design requirements in effect at the time of the installation. The actual test method(s) and performance criteria shall be discussed in advance with the authority having jurisdiction. A flow test shall be conducted every five years.

Table 3-2.3

Check Points	Components	Corrective Action
	Hose Valve Outlets	
1. Cap missing.		1. Replace.
2. Fire hose connection damaged.		2. Repair.
3. Valve handles missing.		3. Replace.
4. Cap gaskets missing or deterioriated.		4. Replace.
5. Valve leaking.		5. Close or repair.
6. Visible obstructions.		6. Remove
7. Restricting device missing.		7. Replace.
	Piping	
1. Damaged piping.		1. Repair.
2. Control valves damaged.		2. Repair or replace.
3. Missing or damaged pipe support device.		3. Repair or replace.
4. Damaged supervisory devices.		4. Repair or replace.
	Hose	
1. Inspect		1. The hose, including gaskets, shall be removed and inspected and the hose re-racked or re-reeled at intervals in accordance with NFPA 1962, *Standard for the Care, Use, and Maintenance of Fire Hose Including Couplings and Nozzles.*
2. Mildew, cuts, abrasions, and deterioration evident.		2. Replace with listed lined, jacketed hose.
3. Coupling damaged.		3. Replace or repair.
4. Gaskets missing or deteriorated.		4. Replace.
5. Incompatible threads on coupling.		5. Replace or provide thread adapter.
6. Hose not connected to hose rack nipple or valve.		6. Connect.
7. Hose test date outdated.		7. Retest or replace in accordance with NFPA 1962, *Standard for the Care, Use, and Maintenance of Fire Hose Including Couplings and Nozzles.*
	Hose Nozzle	
1. Hose nozzle missing.		1. Replace with listed nozzle.
2. Gasket missing or deteriorated.		2. Replace.
3. Obstructions.		3. Remove.
4. Nozzle does not operate smoothly.		4. Repair or replace.
	Hose Storage Device	
1. Difficult to operate.		1. Repair or replace.
2. Damaged.		2. Repair or replace.
3. Obstruction.		3. Remove.
4. Hose improperly racked or rolled.		4. Remove.
5. Nozzle clip in place and nozzle correctly contained?		5. Replace if necessary.
6. If enclosed in cabinet, will hose rack swing out at least 90 degrees?		6. Repair or remove any obstructions.
	Cabinet	
1. Check overall condition for corroded or damaged parts.		1. Repair or replace parts. Replace entire cabinet if necessary.
2. Difficult to open.		2. Repair.
3. Cabinet door will not open fully.		3. Repair or move obstructions.
4. Door glazing cracked or broken.		4. Replace.
5. If cabinet is break-glass type, is lock functioning properly?		5. Repair or replace.
6. Glass break device missing or not attached.		6. Replace or attach.
7. Not properly identified as containing fire equipment.		7. Provide identification.
8. Visible obstructions.		8. Remove.
9. All valves, hose, nozzles, fire extinguisher, etc., easily accessible.		9. Remove any material not related.

3-3.1.2 All systems shall be flow and pressure tested at the requirements in effect at the time of the installation. The actual test method(s) and performance criteria shall be discussed in advance with the authority having jurisdiction.

3-3.1.3 Standpipes, sprinkler connections to standpipes, or hose stations equipped with pressure reducing or pressure regulating valves shall have these valves inspected, tested, and maintained in accordance with the requirements in Chapter 9 of this standard.

3-3.2 Hydrostatic Tests.

3-3.2.1 Hydrostatic tests at not less than 200 psi (13.8 bars) pressure for 2 hr, or at 50 psi (3.4 bars) in excess of the maximum pressure, when maximum pressure is in excess of 150 psi (10.3 bars), shall be conducted at least every five years on dry standpipe systems and dry portions of wet standpipe systems.

3-3.2.2* Hydrostatic tests shall be conducted in accordance with 3-3.2.1 on any system that has been modified or repaired or when an inspection indicates that there is reason to believe that this system would fail to operate properly in an emergency.

3-3.2.3 The hydrostatic test pressure shall be measured at the low elevation point of the individual system or zone being tested. The inside standpipe piping shall show no leakage.

3-3.3 Alarm Devices. Where provided, waterflow alarm and supervisory devices shall be tested on a quarterly basis.

Exception: Where freezing conditions necessitate a delay in testing, tests shall be performed as soon as weather permits.

3-4 Maintenance. Maintenance shall be in accordance with 3-2.3.

3-5 Records. Records shall be maintained in accordance with Chapter 1.

Chapter 4 Private Fire Service Mains

4-1 General.

4-1.1 This chapter provides the minimum requirements relative to the routine inspection, testing, and maintenance of private fire service mains and their appurtenances. In many instances it is permitted to carry out these functions simultaneously.

Exception No. 1: Fire department connections installed in private fire service mains are covered in Chapter 9.

Exception No. 2: Fire hose shall be maintained in accordance with NFPA 1962, Standard for the Care, Use, and Maintenance of Fire Hose Including Couplings and Nozzles.

4-1.2 Impairments. The inspection, testing, and maintenance of private fire service mains may involve or result in fire protection being out of service. The procedures outlined in Chapter 10 shall be followed wherever such an impairment to fire protection occurs.

4-1.3 Notification to Supervisory Service. To avoid false alarms where a supervisory service is provided, the alarm receiving facilities shall always be notified by the owner or designated representative:

(a) Before conducting any test or procedure that could result in the activation of an alarm, and

(b) After such tests or procedures are concluded.

4-2 Definitions.

4-2.1 Fire Department Connection. A connection through which the public fire department can pump water into the sprinkler system, standpipe, or other system furnishing water for fire extinguishment to supplement existing water supplies. (*See Chapter 9.*)

4-2.2* Fire Hydrants. Connected to water mains for the purpose of supplying water to fire hoses or other fire protection apparatus.

Table 4-1

Item	Activity	Frequency	Section Number
Hose/Hydrant Houses	Inspection	Monthly	4-3.2.7
Hydrants (Dry Wall)	Inspection	Semiannually & after each operation	4-3.2.4
Monitor Nozzles	Inspection	Semiannually	4-3.2.6
Hydrants (Wet)	Inspection	Annually & after each operation	4-3.2.5
Mainline Strainer	Inspection	Annually & after each significant flow	4-3.2.3
Piping (Exposed)	Inspection	Annually	4-3.2.1
Piping (Underground)	Inspection	*	4-3.2.2
Monitor Nozzles	Test	Flow-Annually (Range-Operation) Semiannually	4-4.3
Hydrants	Test	Annually	4-4.2
Piping (Exposed and Underground)	Flow Test	5 Year	4-4.1.1
Mainline Strainer	Maintenance	Annually & after each operation	4-5.2
Hose/Hydrant Houses	Maintenance	Annually	4-5.5
Hydrants	Maintenance	Annually	4-5.3
Monitor Nozzles	Maintenance	Annually	4-5.4

4-2.3* Monitor Nozzles. Devices specifically designed with large clear waterways to give a powerful, far-reaching stream for the protection of large amounts of combustible materials, aircraft, tank farms, and any other special hazard locations where large amounts of water must be instantly available without the delay of laying hose lines. The nozzle is normally fitted with one of three interchangeable tips, 1½ in., 1¾ in., and 2 in., (38, 45, and 51 mm).

4-2.4* Dry Barrel Hydrant (frostproof hydrant). The most common type of hydrant, whose control valve is below the frost line between the footpiece and the barrel. A drain hole is located at the bottom of the barrel above the control valve seat for proper drainage after operation.

4-2.5* Wet Barrel Hydrant. A type of hydrant that is sometimes used where there is no danger of freezing weather. In this case, each outlet is provided with a valved outlet threaded for fire hose.

4-2.6* Wall Hydrant. A hydrant mounted on the outside of a wall of a building, fed from interior piping, and with control valves located inside the building, normally key operated from the building's exterior.

4-2.7* Monitor Nozzle Hydrant. A hydrant equipped with a monitor nozzle capable of delivering more than 250 gpm (946 L/min).

4-2.8* Hose/Hydrant House. A substantial structure located over or adjacent to a hydrant or other water supply so designed to contain the necessary hose nozzles, hose wrenches, gaskets, and spanners to be used in fire fighting in conjunction with and aiding the local fire department. Depending on the size and location, these houses may be wall mounted for convenience.

4-3 Inspection.

4-3.1 General. Private fire service mains and their appurtenances shall be inspected at the intervals specified for the conditions outlined in Table 4-1.

4-3.2 Procedures. The following requirements outline inspection intervals, conditions to be inspected, and corrective actions necessary for private fire service mains and associated equipment. All procedures shall be carried out in accordance with the manufacturer's instructions, where applicable.

4-3.2.1 Piping — Exposed. Exposed piping shall be inspected annually. Piping shall be inspected, and the necessary corrective action shall be taken as shown in Table 4-3.2.1.

Exception: Piping in areas that are inaccessible for safety considerations due to process operations shall be inspected during each scheduled shutdown.

4-3.2.2 Piping — Underground. Generally, underground piping cannot be inspected on a routine basis. However, flow testing can reveal the condition of underground piping and shall be conducted in accordance with Section 4-4.

Table 4-3.2.1

Condition	Corrective Action
- Leaks	- Repair
- Physical Damage	- Repair or replace
- Corrosion	- Clean or replace and coat with corrosion protection
- Restraint methods	- Repair or replace

4-3.2.3* Mainline Strainers. Mainline strainers shall be cleaned after each significant systems flow and shall be removed and inspected annually for failing, damaged, and corroded parts.

Table 4-3.2.3

Condition	Corrective Action
- Plugging or fouling	- Clean
- Corrosion	- Replace or repair

4-3.2.4 Hydrants — Dry Barrel and Wall. Dry barrel and wall hydrants shall be inspected semiannually and after each operation. Hydrants shall be inspected and the necessary corrective action shall be taken as shown in Table 4-3.2.4.

Table 4-3.2.4

Condition	Corrective Action
- Accessibility	- Make accessible
- Barrel contains water or ice (presence of water or ice may indicate a faulty drain, a leaky hydrant valve, or high groundwater table)	- Repair and drain; for high groundwater it may be necessary to plug the drain and pump out the barrel after each use
- Improper drainage from barrel	- Repair drain
- Leaks in outlets or at top of hydrant	- Repair or replace gaskets, packing, or parts as necessary
- Cracks in hydrant barrel	- Repair or replace
- Tightness of outlets	- Lubricate if necessary; tighten if necessary
- Worn nozzle threads	- Repair or replace if worn
- Worn hydrant operating nut	- Repair or replace
- Availability of operating wrench	- Make sure wrench is available

4-3.2.5 Hydrants — Wet Barrel. Wet barrel hydrants shall be inspected annually and after operation. Hydrants shall be inspected and the necessary corrective action shall be taken as shown in Table 4-3.2.5 on the following page.

4-3.2.6 Monitor Nozzles. Monitor nozzles shall be inspected semiannually. Nozzles shall be inspected and the necessary corrective action shall be taken as shown in Table 4-3.2.6 on the following page.

Table 4-3.2.5

Condition	Corrective Action
- Accessibility	- Make accessible
- Leaks in outlets or at top of hydrant	- Repair or replace gaskets, packing, or parts as necessary
- Cracks in hydrant barrel	- Repair or replace
- Tightness of outlets	- Lubricate if necessary; tighten if necessary
- Worn nozzle threads	- Repair or replace
- Worn hydrant operating nut	- Repair or replace
- Availability of operating wrench	- Make sure wrench is available

Table 4-3.2.6

Condition	Corrective Action
- Leakage	- Repair
- Physical damage	- Repair or replace
- Corrosion	- Clean or replace, and lubricate or protect as necessary

4-3.2.7 Hose/Hydrant Houses. Hose/hydrant houses shall be inspected monthly. Houses shall be inspected and the necessary corrective action shall be taken as shown in Table 4-3.2.7.

Table 4-3.2.7

Condition	Corrective Action
- Accessibility	- Make accessible
- Physical damage	- Repair or replace
- Missing equipment	- Replace equipment

4-4 Testing.

4-4.1 Underground and Exposed Piping.

4-4.1.1* Flow Tests. Underground and exposed piping shall be flow tested to determine the internal condition of the piping at minimum five-year intervals. Flow tests shall be made at flows representative of those expected during a fire, for the purpose of comparing friction loss characteristics of the pipe with that expected for the particular type of pipe involved, with due consideration given to the age of the pipe and to the results of previous flow tests. Any flow test results that indicate deterioration of available water flow and pressure shall be fully investigated to the satisfaction of the authority having jurisdiction to ensure that adequate flow and pressure are available for fire protection.

4-4.2 Hydrants. Hydrants shall be tested at minimum annually to ensure proper functioning. Each hydrant shall be fully opened and water flowed until all foreign material has cleared, but for a duration of not less than 1 min.

After operation, dry barrel and wall hydrants shall be observed for proper drainage from the barrel. Full drainage shall take no longer than 60 min. When soil conditions or other factors are such that the hydrant barrel will not drain within 60 min., or when the groundwater level is above that of the hydrant drain, the hydrant drain shall be plugged and the water in the barrel shall be pumped out. Dry barrel hydrants in areas subject to freezing weather and that have plugged drains shall be clearly identified as needing to be pumped out after operation.

4-4.3 Monitor Nozzles. Monitor nozzles that are mounted on hydrants shall be tested according to 4-4.2. Additionally, all monitor nozzles shall be oscillated and moved throughout their full range at least semiannually to ensure proper operability.

4-4.4 Hose/Hydrant Houses. All fire hose shall be tested in accordance with NFPA 1962, *Standard for the Care, Use, and Maintenance of Fire Hose Including Couplings and Nozzles.*

4-5 Maintenance.

4-5.1 General. All equipment shall be maintained in proper working condition, consistent with manufacturer's recommendations.

4-5.2 Mainline Strainers. Mainline strainers shall be cleaned at least annually and after each operation.

4-5.3 Hydrants.

4-5.3.1 Hydrants shall be lubricated at least annually to ensure that all stems, caps, plugs, and threads are in proper operating condition.

4-5.3.2* Hydrants shall be kept free of snow, ice, or other materials and protected against mechanical damage so that free access is ensured.

4-5.4 Monitor Nozzles. Monitor nozzles shall be lubricated at least annually to ensure proper operating condition.

4-5.5 Hose/Hydrant Houses. Hose/hydrant houses shall be maintained annually in a condition to assure that all fire hose and required components are in usable condition.

4-6 Records. Records shall be maintained in accordance with Chapter 1.

Chapter 5 Fire Pumps

5-1 General.

5-1.1 This chapter provides the minimum requirements relative to the periodic inspection, testing, and maintenance of fire pump assemblies. See Table 5-1 for the minimum required frequencies for inspection, testing, and maintenance.

Exception: Valves shall be inspected, tested, and maintained in accordance with Chapter 9.

5-1.2* A fire pump assembly provides waterflow and pressure for private fire protection. The assembly includes the water supply suction and discharge piping and valving; pump; electric, diesel, or steam turbine driver and control; and auxiliary equipment appurtenant thereto.

Table 5-1 Summary of Inspection, Testing, and Maintenance

Item	Activity	Frequency	Section No.
Pump house,		Weekly during	
heating	Insepction	heating season	Table 5-2.2
ventilating louvers	Inspection	Weekly	Table 5-2.2
Fire pump system	Inspection	Weekly	Table 5-2.2
Pump operation,			
no-flow condition	Test	Weekly	5-3.2.1, 5-3.2.2
flow condition	Test	Annually	5-3.3
Hydraulic	Maintenance	Annually	5-5.1
Mechanical transmission	Maintenance	Annually	5-5.1
Electrical system	Maintenance		
Controller, various components	Maintenance	Varies	5-5.1
Motor	Maintenance	Annually	5-5.1
Diesel engine system various components	Maintenance	Varies	5-5.1

5-1.3 The pump assembly auxiliary equipment includes:

(a) Pump accessories

1. Pump shaft coupling
2. Automatic air release valve
3. Pressure gauges
4. Circulation relief valve (not used in conjunction with diesel engine drive with heat exchanger).

(b) Pump test device(s)

(c) Pump relief valve and piping (where maximum pump discharge pressure exceeds the rating of the system components or the driver is of variable speed)

(d) Alarm sensors and indicators

(e) Right-angle gear sets (for engine driven vertical shaft turbine pumps)

(f) Pressure maintenance (jockey) pump and accessories.

5-1.4 This chapter specifies the required inspection, tests, and maintenance procedures to be performed, including the frequency thereof, on fire pumps, drivers, controllers, and accessories covered in NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*. Further, it specifies requirements for the adequacy of the energy source(s) and water supply for the above fire pump systems as determined by tests and inspections required to be made, including the frequency thereof.

5-1.5 Water Supply to Pump Suction. The suction supply for the fire pump shall be adequate to provide the flow and suction pressure required to meet the system demand.

5-1.6 Energy Source. The energy sources for the pump driver shall be adequate to supply the necessary brake horsepower of the driver so that the pump meets system demand.

5-1.7 Driver. The pump driver shall not overload beyond its rating (including any service factor allowance) when delivering the necessary brake horsepower.

5-1.8* Controller. Automatic and manual controllers for applying the energy source to the driver shall be capable of providing this operation for the type of pump used.

5-1.9 Impairments. The inspection, testing, and maintenance of fire pump assemblies may involve or result in a system being out of service. The procedures outlined in Chapter 10 of this standard shall be followed when such an impairment to protection occurs.

5-1.10 Notification to Supervisory Service. To avoid false alarms where a supervisory service is provided, the alarm receiving facilities shall always be notified by the owner or designated representative:

(a) Before conducting any test or procedure that could result in the activation of an alarm, and

(b) After such tests or procedures are concluded.

5-2 Inspection.

5-2.1 The purpose of inspection is to verify that the pump assembly appears to be in operating condition and is free from physical damage.

5-2.2* The pertinent visual observations listed in Table 5-2.2 shall be performed weekly.

5-3 Testing.

5-3.1 Purpose. The purpose of testing the pump assembly is to ensure automatic or manual operation upon demand and continuous delivery of the required system output. An additional purpose is to detect deficiencies of the pump assembly not evident by inspection.

5-3.2 Weekly Tests. Qualified operating personnel shall be in attendance during the weekly pump operation.

5-3.2.1 A weekly test of electric motor-driven pump assemblies shall be conducted without flowing water. This test shall be conducted by allowing automatic starting of the pump to occur. Pump shall run a minimum of 10 minutes.

Exception: Water shall discharge from the circulating relief valve when installed.

Table 5-2.2
Weekly Inspection Observations

Pump House Conditions
Heat adequate, not less than 40°F (70°F for pump room with diesel pumps without engine heaters)
Ventilating louvers free to operate
Hydraulic System Conditions
Pump suction and discharge, and bypass valves fully open
Inspect for piping leaks
Suction line pressure gauge reading normal
System line pressure gauge reading normal
Suction reservoir full
Electrical System Conditions
Controller pilot light (power on) illuminated
Transfer switch normal pilot light illuminated
Isolating switch closed - standby (emergency) source
Reverse phase alarm pilot light off, or normal phase rotation pilot light on
Oil level in vertical motor sight glass normal
Diesel Engine System Conditions
Fuel tank two-thirds full
Controller selector switch in AUTO position
Batteries (2) voltage readings normal
Batteries (2) charging current readings normal
Batteries (2) pilot lights on or battery failure (2) pilot lights off
All alarm pilot lights off
Engine running time meter reading
Oil level in right angle gear drive normal
Crankcase oil level normal
Cooling water level normal
Electrolyte level in batteries normal
Battery terminals free from corrosion
Water-jacket heater operating
Steam System Conditions
Steam pressure gauge reading normal

NOTE: Visual indicators other than pilot lights may be used for the same purpose.

5-3.2.2 A weekly test of diesel engine-driven pump assemblies shall be conducted without flowing water. This test shall be conducted by allowing automatic starting of the pump to occur, and the pump shall run a minimum of thirty minutes.

5-3.2.2.1 The automatic weekly test timer shall be permitted to be substituted for the starting procedure.

5-3.2.3 A weekly test of steam turbine-driven pump assemblies shall be conducted.

5-3.2.4* The pertinent visual observations or adjustments listed in Table 5-3.2.4 shall be conducted while the pump is running.

Table 5-3.2.4 Weekly Test Procedure

Hydraulic System Procedure
Record system suction and discharge pressure gauge readings
Check pump packing glands for slight discharge
Adjust gland nuts if necessary
Check for unusual noise or vibration
Check packing boxes, bearings, or pump casing for overheating
Record pump starting pressure
Electrical System Procedure
Observe time for motor to accelerate to full speed
Record time controller is on first step (for reduced voltage or reduced current starting)
Record time pump runs after starting (for automatic stop controllers)
Diesel System Procedure
Observe time for engine to crank
Observe time for engine to reach running speed
Observe engine oil pressure gauge, speed indicator, water, and oil temperature indicators periodically while engine is running. Record any abnormalities.
Check heat exchanger for cooling water flow
Steam System Procedure
Record steam pressure gauge reading
Observe time for turbine to reach running speed

5-3.3 Annual Tests.

5-3.3.1* An annual test of any pump assembly shall be conducted with power output adjusted to "no load," "rated load," and "peak load." This test shall be conducted in one of the following ways:

(a) Using pump discharge via hose streams, pump suction, and discharge pressures, and flow measurements of each hose stream shall determine the total pump output.

NOTE: Care should be taken to prevent water damage by verifying there is adequate drainage for the high pressure water discharge from hoses.

(b) Using pump discharge via by-pass flow meter to drain or suction reservoir, pump suction, and discharge pressures, and flow meter measurements shall determine the total pump output.

(c) Using pump discharge via by-pass flow meter to pump suction (closed-loop metering), pump suction, and discharge pressures, and flow meter measurements shall determine the total pump output.

When the annual test is periodically conducted in accordance with (c), a test shall be conducted at least every 3 years in accordance with (a) or (b) in lieu of (c).

5-3.3.2 The pertinent visual observations, measurements, and adjustments listed in Table 5-3.3.2 shall be conducted while the pump is running and flowing water under the specified output condition.

Table 5-3.3.2 Annual Test Procedure

At No Flow Condition (Churn) (Conduct this Test First)
Check circulation relief valve for operation to discharge water (see 9-5.4)
Check pressure relief valve (if installed) for proper operation (see 9-5.4)
Continue test for one-half hr
At Each Flow Condition
Record electric motor voltage and current (all lines)
Record pump speed in rpm
Record simultaneous (approximately) readings of pump suction and discharge pressures and pump discharge flow
Observe operation of any alarm indicators or any visible abnormalities (see 9-5.4.1.1)

5-3.3.3 For installations having a device installed to control minimum suction pressure by throttling action, low suction pressure on the device (below set minimum value) shall be simulated while pumping at rated flow. Observe throttling action for any abnormality (cavitation, pressure surges, failure to throttle, etc.). Remove simulated low suction pressure on device and again observe action for any abnormality as pump returns to full flow.

5-3.3.4 For installations having an automatic transfer switch, the following test shall be performed to ensure that the overcurrent protective devices (fuse or circuit breaker) do not open. Simulate normal power failure while pump is delivering peak power output to cause connection of the pump motor to the alternate power source. Restore pump peak power output (if necessary), then remove simulated normal power failure condition, which shall, after a time delay, cause the reconnection of the pump motor to the normal power source.

5-3.3.5 Alarm conditions shall be simulated by activating alarm circuits at alarm sensor locations, and all such local or remote alarm indicating devices (visual and audible) shall be observed for operation.

5-3.4 Other Tests.

5-3.4.1 Engine generator sets supplying emergency or standby power to fire pump assemblies shall be routinely tested in accordance with NFPA 110, *Standard for Emergency and Standby Power Systems.*

5-3.4.2 Automatic transfer switches shall be routinely tested and exercised in accordance with NFPA 110, *Standard for Emergency and Standby Power Systems.*

5-3.4.3 Tests of appropriate environmental pump room space conditions shall be made (heating, ventilation, illumination, etc.) to ensure proper manual or automatic operation of equipment associated therewith.

5-3.5 Test Results and Evaluation.

5-3.5.1 The interpretation of the test results shall be the basis of determination of adequacy of the pump assembly. Such interpretation shall be made by those skilled in such matters.

5-3.5.2* The curve shall be compared to the unadjusted field acceptance test curve and the previous year's test curve. The pump shall be capable of supplying the maximum system demand.

5-4 Reports.

5-4.1 Any abnormality observed during inspection or testing shall be promptly reported to the person responsible for correcting the abnormality.

5-4.2 Test results shall be recorded and retained for comparison purposes in accordance with Chapter 1. Record all time delay intervals associated with pump starting, stopping, and energy source transfer (*see 5-3.3.4*).

5-5 Maintenance.

5-5.1* A preventive maintenance program shall be established on all components of the pump assembly in accordance with the manufacturer's recommendations. Records shall be maintained on all work performed on the pump, driver, controller, and auxiliary equipment.

In the absence of manufacturer's recommendations for preventive maintenance, Table 5-5.1 indicates alternate requirements.

5-5.2 The preventive maintenance program shall be initiated immediately after the pump assembly has passed acceptance tests.

Table 5-5.1 Fire Pump Systems Maintenance Schedule

	Complete as Applicable	Visual Inspection	Check	Change	Clean	Test	Frequency
A.	Hydraulic System						
	Lubricate pump bearings			X			Annually
	Check shaft end play, and adjust if necessary		X				Annually
	Check accuracy of pressure sensor			X			When 15% out of calibration
	Check pump coupling alignment		X				Annually
B.	Mechanical Transmission						
	Lubricate coupling			X			Annually
	Lubricate right-angle gear drive			X			Annually
C.	Electrical System						
	1. Exercise isolating switch & circuit breaker					X	Monthly
	2. Trip circuit breaker (if mechanism provided)					X	Annually
	3. Operate manual starting means (electrical)					X	Semiannually
	4. Inspect and operate emergency manual starting means (without power)	X				X	Annually
	5. Tighten electrical connections as necessary		X				Annually
	6. Lubricate mechanical moving parts (excluding starters and relays)		X				Annually
	7. Calibrate pressure switch settings		X				Annually
	8. Grease motor bearings			X			Annually
D.	Diesel Engine System						
	1. Fuel						
	(a) Tank level	X	X				Weekly
	(b) Tank float switch	X				X	Weekly
	(c) Solenoids valve operation	X				X	Weekly
	(d) Strainer, filter and/or dirt leg				X		Quarterly
	(e) Water and foreign material in tank				X		Annually
	(f) Water in system		X		X		Weekly
	(g) Flexible hoses and connectors	X		R			Weekly
	(h) Tank vents and overflow piping unobstructed		X			X	Annually
	(i) Piping	X					Annually
	2. (a) Lubrication System—Oil level	X	X				Weekly
	(b) Oil change			R			50 hours or Annually
	(c) Oil filter(s)			X			50 hours or Annually
	(d) Lube oil heater		X				Weekly
	(e) Crankcase breather	X		R	X		Quarterly
	3. (a) Cooling System—Level	X	X				Weekly
	(b) Antifreeze protection level					X	Semiannually
	(c) Antifreeze			X			Annually
	(d) Adequate cooling water to heat exchanger		X				Weekly
	(e) Rod out heat exchanger				X		Annually
	(f) Water pump(s)	X					Weekly
	(g) Condition of flexible hoses and connections	X	X				Weekly
	(h) Jacket water heater		X				Weekly
	(i) Inspect duct work, clean louvers (combustion air)	X	X	X			Annually
	(j) Water strainer				X		Quarterly
	4. (a) Exhaust System—Leakage	X	X				Weekly
	(b) Drain condensate trap		X				Weekly
	(c) Insulation and fire hazards	X					Quarterly
	(d) Excessive back pressure					X	Annually
	(e) Exhaust system hangers and supports	X					Annually
	(f) Flexible exhaust section	X					Semiannually
	5. (a) Battery System—Electrolyte Level		X				Weekly
	(b) Terminals cleans and tight	X	X				Quarterly
	(c) Remove corrosion, case exterior clean and dry	X		X			Monthly
	(d) Specific gravity or state of charge					X	Monthly
	(e) Charger and charge rate	X					Monthly
	(f) Equalize charge		X				Monthly
	6. (a) Electrical System—General Inspection	X					Weekly
	(b) Tighten control and power wiring connections		X				Annually
	(c) Wire chafing where subject to movement	X	X				Quarterly
	(d) Operation of safeties and alarms		X			X	Semiannually
	(e) Boxes, panels and cabinets				X		Semiannually
	(f) Circuit breakers fuses (every 2 years or as needed)	X	X	R	X	X	Monthly

R — Replace

Chapter 6 Water Storage Tanks

6-1 General.

6-1.1* This chapter provides the minimum requirements relative to the routine inspection, testing, and maintenance of water storage tanks. See Table 6-1 for the minimum required frequencies for inspection, testing, and maintenance.

Exception: Requirements for valves common to other types of water-based fire protection systems are found in Chapter 9 and listed in Table 6-1.

6-1.2 Impairments. The inspection, testing, and maintenance of water storage tanks may involve or result in a system being out of service. The procedures outlined in Chapter 10 of this standard shall be followed when such an impairment to protection occurs.

6-1.3 Notification to Supervisory Service. To avoid false alarms where a supervisory service is provided, the alarm receiving facilities shall always be notified by the owner or designated representative:

(a) Before conducting any test or procedure that could result in the activation of an alarm, and

(b) After such tests or procedures are concluded.

6-2 Inspection.

6-2.1* The water level and the condition of the water in the tank shall be inspected at least monthly.

6-2.2* The exterior of the tank, supporting structure, and catwalks or ladders, where provided, shall be inspected for signs of obvious damage or weakening at least monthly.

6-2.3 The area surrounding the tank and supporting structure, where provided, shall be inspected at least monthly to ensure that:

(a) The area is free of combustible storage, trash, debris, brush, or material that could present a fire exposure.

(b) The area is free of accumulation of material on or near parts that could result in accelerated corrosion or rot.

(c) The tank and support are free of ice build-up.

(d) The exterior sides and top of like walls are free of erosion (Embankment-Supported Rubberized-Fabric tanks only).

Table 6-1 Summary of Inspection, Testing, and Maintenance

Item	Activity	Frequency	Section Number
Condition	Inspection	Daily*	6-2.1
Water Temperature	Inspection	Daily*	6-2.9
Heating System	Inspection	Daily*	6-2.8
Control Valves	Inspection	Weekly/Monthly	9-2.3
Water—Level	Inspection	Monthly	6-2.1
Air Pressure	Inspection	Monthly	6-2.7
Tank—Exterior	Inspection	Monthly	6-2.2
Support Structure	Inspection	Monthly	6-2.2
Catwalks and Ladders	Inspection	Monthly	6-2.2
Surrounding Area	Inspection	Monthly	6-2.3
Hoops & Grillage	Inspection	Annually	6-2.5
Painted/Coated Surfaces	Inspection	Annually	6-2.6
Expansion Joints	Inspection	Annually	6-2.10
Interior	Inspection	5 Years	6-2.4
Check Valves	Inspection	5 Years	9-3.1
Temperature Alarms	Testing	Monthly*	6-3.3
High Temp. Limit Switches	Testing	Monthly*	6-3.4
Water Level Alarms	Testing	Semiannually	6-3.5
Level Indicators	Testing	5 Years	6-3.1
Pressure Gauges	Testing	5 Years	6-3.6
Water Level	Maintenance	—	6-4.1
Thermostats	Maintenance	—	6-4.7
Drain Sediment	Maintenance	Semiannually	6-4.3
Cathodic Protection	Maintenance	Annually	6-4.5
Drain Valves Cycled	Maintenance	Annually	6-4.8
Vent Screens	Maintenance	Annually	6-4.9
Control Valves	Maintenance	Annually	9-2.4
Repainting—Steel	Maintenance	—	6-4.16
Embankment-Supported Rubberized-Fabric (ESRF)	Maintenance	—	6-4.17
Check Valves	Maintenance	—	9-3.2

* Cold weather/heating season only.

6-2.4 The interior of the tank shall be inspected at least every five years.

Exception No. 1: The interior of steel tanks without corrosion protection shall be inspected at least every two years.

Exception No. 2: The interior of pressure tanks shall be inspected at least every three years.

6-2.5 The hoops and grillage of wooden tanks shall be inspected at least every two years.

6-2.6 Exterior painted, coated, or insulated surfaces of the tank and supporting structure, where provided, shall be inspected for signs of degradation at least annually.

6-2.7 The air pressure in pressure tanks shall be inspected at least monthly.

6-2.8 The heating system, where provided, shall be inspected during the heating season at least daily.

6-2.9 The water temperature shall be inspected and recorded daily (cold weather only). The coldest water temperature shall not be less than 40°F (4°C).

6-2.10 Expansion joints, where provided, shall be inspected for leaks and cracks at least annually.

6-2.11 All control valves involved with water storage tanks shall be inspected at the following intervals:

(a) Sealed valves — weekly

(b) Locked valves and valves with tamper switches — monthly.

Valves shall be maintained as mandated in Chapter 9.

6-3 Testing.

6-3.1* Level indicators shall be tested for accuracy and freedom of movement at least every five years.

6-3.2 The tank heating system, where provided, shall be tested prior to the heating season to be sure it is in the proper working order.

6-3.3 Low water temperature alarms, where provided, shall be tested monthly (cold weather only).

6-3.4* High water temperature limit switches on tank heating systems, where provided, shall be tested monthly whenever the heating system is in service.

6-3.5* High and low water level alarms shall be tested at least semiannually.

6-3.6* Pressure gauges shall be tested with a calibrated gauge in accordance with the manufacturer's instructions at least every five years. Gauges not accurate to within 3 percent of the scale of the gauge being tested shall be calibrated or replaced.

6-4 Maintenance.

6-4.1 The tank shall be maintained full or at the designed water level.

6-4.2 The interior and exterior of any tank, along with the supporting structure, where provided, shall be maintained free of peeling paint, aquatic growth, sediment, foreign matter, tools, painting equipment, or any other material that may interfere with proper operation of the tank.

6-4.3 Sediment shall be drained or flushed from the tank at least semiannually.

6-4.4 The tank and supporting structure, where provided, shall be protected from rot, corrosion, rust, mechanical damage, accumulation of debris, and sediment. The tops of foundation piers shall be maintained at least 6 in. (152 mm) above ground level.

6-4.5 Cathodic protection, where provided, shall be maintained annually in accordance with the manufacturer's instructions.

6-4.6 Check valves, where installed, shall be maintained in accordance with Chapter 9.

6-4.7 Tank thermometers shall be maintained in accordance with the manufacturer's instructions.

6-4.8 All tank drain valves shall be fully opened and closed at least annually.

6-4.9 Tank vents shall be cleaned at least annually.

6-4.10 Valve pits and valve or heater houses shall be maintained at a minimum temperature of 40°F (4°C), weather-tight and free of water accumulations.

6-4.11* Tank heating systems shall be maintained in accordance with the manufacturer's instructions. The coldest water in the tank shall not be less than 40°F (4°C).

6-4.12 Repair work and replacement parts shall meet the original design criteria and meet the installation standard of NFPA 22, *Standard for Water Tanks for Private Fire Protection.*

6-4.13 Repairs to the tank shall be made only with materials that will not become loose or dislodged and obstruct the outlet.

6-4.14 All welding performed on the tank shall be completed and tested in accordance with AWWA D100 (AWS D5.2), *Standard for Welded Steel Tanks for Water Storage*, from the American Water Works Association.

6-4.15 During interior tank maintenance and painting activities, a protective cover of no more than a few sheets of paper shall be used to cover the outlet opening. This protective covering shall be removed prior to returning the tank to service.

6-4.16* Repainting of Steel Tanks. Repainting shall be done only on dry surfaces thoroughly cleaned of all base paint, rust, scale, or other surface contamination.

6-4.17 Maintenance. The maintenance of ESRF tanks shall be completed in accordance with the particular tank manufacturer's instructions.

6-5 Records. Records shall be maintained in accordance with Chapter 1.

Chapter 7 Water Spray Fixed Systems

7-1 General.

7-1.1* Reference shall be made to NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, to determine the requirements for design and installation, including acceptance testing.

7-1.2* This chapter provides minimum requirements relative to the routine inspection, testing, and maintenance of water spray protection from fixed nozzle systems only. (*See Table 7-4.*) This chapter does not cover water spray protection from portable nozzles, sprinkler systems, monitor nozzles, or other means of application.

Exception: Requirements for valves and fire department connections are found in Chapter 9.

7-1.3 The effectiveness and reliability of water spray fixed systems depends on maintenance of the integrity of hydraulic characteristics, water control valves, deluge valves and their fire detection/actuation systems, pipe hangers, and prevention of obstructions to nozzle discharge patterns.

7-1.4 Many of the components and subsystems found in a water spray system require the same inspection, test, and maintenance procedures required when they are used in automatic sprinkler systems and other fixed water-based fire protection systems. Reference shall be made to other chapters of this standard for particulars about required inspection and maintenance.

7-2 Definitions.

7-2.1* Automatic Detection Equipment. Equipment that will automatically detect heat, flame, products of combustion, flammable gases, or other conditions likely to produce fire or explosion and cause other automatic actuation of alarm and protection equipment.

7-2.2 Deluge Valve. A water supply control valve intended to be operated by actuation of an automatic detection system that is installed in the same area as the water spray nozzles. Each control valve must also be capable of being operated manually.

7-2.3* Strainer. A device capable of removing from the water all solids of sufficient size to obstruct water spray nozzles.

7-2.4 Water Spray. Refers to the use of water in a form having a predetermined pattern, particle size, velocity, and density discharged from specially designed nozzles or devices. Water spray fixed systems are usually applied to special fire protection problems, since the protection can be specifically designed to provide for fire control, extinguishment, or exposure protection. Water spray fixed systems may be independent of, or supplementary to, other forms of protection.

7-2.5* Water Spray Nozzle. A normally open water discharge device that, when supplied with water under pressure, will distribute the water in a special, directional pattern peculiar to the particular device.

7-3 Impairments. The inspection, testing, and maintenance of water spray systems may involve or result in fire protection being out of service. The procedures outlined in Chapter 10 and this section shall be followed wherever such an impairment to fire protection occurs. When a water spray system or any portion thereof is out of service for any reason, notice shall be given to facility management, the local fire department, the on-site fire brigade, and other authorities having jurisdiction as applicable. A sign shall be posted at each fire department connection or system control valve indicating what portion of the system is out of service. (*Also see Chapter 10.*)

7-4 Inspection and Maintenance Procedures.

7-4.1 The components listed below shall be inspected and maintained at the frequency given in Table 7-4 and in accordance with this standard and the manufacturer's instructions.

Exception No. 1: Items in areas that are inaccessible for safety considerations due to continuous process operations, energized electrical equipment, etc., shall be inspected during each scheduled shutdown but not more than every 18 months.

Exception No. 2: Inspections shall not be required for items in areas with no provision for access and that are not subject to the conditions noted in 7-4.4.1, 7-4.4.2, and 7-4.5.1.

Exception No. 3: Items in areas that are inaccessible for safety considerations shall be tested at an expanded frequency in accordance with Exception No. 2 of 9-4.3.2.2.

7-4.1.1 Other maintenance intervals shall be permitted depending on the results of the visual inspection and operating tests.

7-4.1.2 Deluge valve enclosures shall be inspected weekly during severe weather to ensure that they are heated to prevent freezing.

7-4.1.3 Nozzle discharge patterns and direction shall be checked during the annual test.

7-4.1.4 Nozzle strainers shall be removed, inspected, and cleaned during the flushing procedure for the mainline strainer.

7-4.1.5 Mainline strainers shall be removed and inspected for damaged and corroded parts every five years.

7-4.2 Deluge Valves.

7-4.2.1 Deluge valves shall be inspected, tested, and maintained in accordance with Chapter 9.

7-4.2.2 Where applicable, the deluge valve enclosure shall be maintained at a minimum of 40°F (4°C).

7-4.3 Automatic Detection Equipment. Automatic detection equipment shall be inspected, tested, and maintained in accordance with NFPA 72E, *Standard on Automatic Fire Detectors*, to ensure the detectors are properly located, in place, securely fastened, and protected from corrosion, weather, and mechanical damage and the communication wiring, control panels, or pneumatic tubing system is functional.

Table 7-4 Inspection, Test, and Maintenance Frequencies

Item	Activity	Frequency	Section Number
Check Valves	Inspection		7-4.8, Chapter 9
Control Valves	Inspection	Weekly (sealed)	7-4.7.1, 7-4.7.2, Chapter 9
Control Valves	Inspection	Monthly (locked, supervised)	7-4.7.1, 7-4.7.2, Chapter 9
Deluge Valve	Inspection		7-4.2, Chapter 9
Detection Systems	Inspection		NFPA 72E
Detector Check Valves	Inspection		7-4.8, Chapter 9
Drainage	Inspection	Monthly	7-4.10, 7-5.3
Electric Motor	Inspection		7-4.11, Chapter 5
Engine Drive	Inspection		7-4.11, Chapter 5
Fire Pump	Inspection		7-4.11, Chapter 5
Fittings	Inspection	(6) Monthly	7-4.4, 7-4.4.1
Fittings (Rubber Gasketed)	Inspection	(6) Monthly	A-7-4.4.1
Gravity Tanks	Inspection		7-4.12, Chapter 6
Hangers	Inspection	(6) Monthly	7-4.4.2
Heat (Deluge Valve House)	Inspection	Monthly	7-4.2.1
Nozzles	Inspection	(6) Monthly (3)	7-4.5.1
Pipe	Inspection	(6) Monthly	7-4.4, 7-4.4.1
Pressure Tank	Inspection		7-4.12, Chapter 6
Steam Driver	Inspection		7-4.11, Chapter 5
Strainers	Inspection	Mfg Instruction	7-4.9
Suction Tanks	Inspection		7-4.12, Chapter 6
Supports	Inspection	(6) Monthly	7-4.4.2
Water Supply Piping	Inspection		7-4.6.1, 7-4.6.2, Chapter 4
Backflow Preventer	Inspection		7-4.8, Chapter 9
Heat (Deluge Valve House)	Inspection	(2) weekly	7-4.2.2
Check Valves	Maintenance		7-4.8, Chapter 9
Control Valves	Maintenance	(1) Annually	7-4.7.1, Chapter 9
Deluge Valve	Maintenance		7-5 through 7-5.7.2, Chapter 9
Detection Systems	Maintenance		NFPA 72E
Detector Check Valve	Maintenance		7-4.8, Chapter 9
Electric Motor	Maintenance		7-4.11, Chapter 5
Engine Drive	Maintenance		7-4.11, Chapter 5
Fire Pump	Maintenance		7-4.11, Chapter 5
Gravity Tanks	Maintenance		7-4.12, Chapter 6
Pressure Tank	Maintenance		7-4.12, Chapter 6
Steam Driver	Maintenance		7-4.11, Chapter 5
Strainers	Maintenance	(1) Annually (4)	7-4.9
Strainers (baskets/screen)	Maintenance	(1) 5 years (5)	A-7-4.9
Suction Tanks	Maintenance		7-4.12, Chapter 6
Water Spray System	Maintenance	(1) Annually	7-5 through 7-5.7.2, Chapter 9
Backflow Preventer	Maintenance		7-4.8, Chapter 9
Check Valves	Operational Test		7-4.8, Chapter 9
Control Valves	Operational Test	Quarterly	7-4.7.1, Chapter 9
Deluge Valve	Operational Test		7-5 through 7-5.7.2, Chapter 9
Detection Systems	Operational Test		NFPA 72E
Detector Check Valve	Operational Test		7-4.8, Chapter 9
Electric Motor	Operational Test		7-4.11, Chapter 5
Engine Drive	Operational Test		7-4.11, Chapter 5
Fire Pump	Operational Test		7-4.11, Chapter 5
Flushing	Operational Test	(7) Annually	7-5 (flushing of connection to riser, part of annual test)
Gravity Tanks	Operational Test		7-4.12, Chapter 6
Main Drain Test	Operational Test	Quarterly	Chapter 9
Manual Release	Operational Test	(7) Annually	7-5.5
Nozzles	Operational Test	(7) Annually (3)	7-5 through 7-5.7.2
Pressure Tank	Operational Test		7-4.12, Chapter 6
Steam Driver	Operational Test		7-4.11, Chapter 5
Strainers	Operational Test	(7) Annually (4)	7-4.9
Suction Tanks	Operational Test		7-4.12, Chapter 6
Water Flow Alarm	Operational Test	Quarterly	Chapter 2
Water Spray System Test	Operational Test	Annually	7-5 through 7-5.7.2, Chapter 9
Water Supply Flow Test	Operational Test		Chapter 4
Backflow Preventer	Operational Test		7-4.8, Chapter 9

1. Refer to 7-4.1.1.
2. Refer to 7-4.1.2.
3. Refer to 7-4.1.3.
4. Refer to 7-4.1.4.
5. Refer to 7-4.1.5.
6. Refer to 7-4.1, Exceptions No. 1 and No. 2.
7. Refer to 7-4.1, Exception No. 3.

7-4.4* System Piping. System piping, fittings, hangers, and supports shall be inspected and maintained to ensure continuity of water delivery to the spray nozzles at full waterflow and design pressure.

7-4.4.1* System Piping and Fittings. System piping and fittings shall be inspected for the following:

(a) Mechanical damage (e.g., broken piping or cracked fittings).

(b) External conditions (e.g., missing or damaged paint or coatings, rust, and corrosion).

(c) Misalignment or trapped sections.

(d) Low point drains (automatic or manual).

(e) Location of rubber gasketed fittings.

7-4.4.2* Hangers and Supports. Hangers and supports shall be inspected for the following conditions and repaired as necessary.

(a) Condition (e.g., missing or damaged paint or coating, rust, and corrosion).

(b) Secure attachment to structural support and piping.

(c) Damaged or missing hangers.

7-4.5* Water Spray Nozzles.

7-4.5.1 Water spray nozzles shall be inspected and maintained to ensure that they are in place, continue to be aimed or pointed in the direction intended in the system design, and are free from external loading and corrosion. Where caps or plugs are required, the inspection shall confirm they are in place and free to operate as intended.

7-4.5.2 Misaligned water spray nozzles shall be adjusted (aimed) by visual means, and the discharge patterns shall be checked at the next scheduled flow test.

7-4.6 Water Supply.

7-4.6.1 The dependability of the water supply shall be assured by regular inspection and maintenance, whether furnished by municipal source, on-site storage tanks, fire pump, or private underground piping systems.

7-4.6.2 Water Supply Piping. Water supply piping shall be maintained free of internal obstruction that may be caused by debris (e.g., rocks, mud, tubercles) or by closed or partially closed control valves. See Chapter 4 for inspection and maintenance requirements.

7-4.7 Control Valves.

7-4.7.1 Gate valves, post indicator valves, wall indicator valves, or other control valves for water supply systems shall be inspected to verify that they are in the open position and properly sealed, locked, or supervised. See Chapter 9 for inspection and maintenance requirements.

7-4.7.2* If a valve is found closed, the reason for the closure shall be thoroughly investigated. The valve shall be reopened and the system returned to service as quickly as possible.

7-4.8 Other Devices. Other devices, such as check valves, detector check valves, and backflow preventers, that are installed in the water supply piping system shall be inspected and maintained so that they do not impede the flow of water and fire main pressure. See Chapter 9 for the inspection and maintenance requirements.

7-4.9* Strainers. Mainline strainers (basket or screen) shall be flushed until clear after each operation or flow test. Individual water spray nozzle strainers shall be removed, cleaned, and inspected after each operation or flow test. All strainers shall be inspected and cleaned in accordance with manufacturer's instructions. Damaged or corroded parts shall be replaced or repaired.

7-4.10 Drainage. The area beneath and surrounding a water spray system shall be visually inspected to ensure that drainage facilities, such as trap sumps and drainage trenches, are not blocked and retention embankments or dikes are in good repair.

7-4.11 Fire Pumps. See Chapter 5 for inspection and maintenance requirements.

7-4.12 Water Tanks (gravity, pressure, or suction tanks, or reservoirs). See Chapter 6 for inspection and maintenance requirements.

7-5 Operational Tests. Water spray systems require competent and effective care and maintenance to ensure they will perform as designed. Systems shall be tested at the frequency shown in Table 7-4. They shall be serviced in accordance with this standard and with the manufacturer's instructions.

7-5.1 Notification.

7-5.1.1 Notification to Supervisory Service. To avoid false alarms where a supervisory service is provided, the alarm receiving facility shall always be notified by the owner or designated representative (1) before conducting any test or procedure that could result in the actuation of an alarm, and (2) after such tests or procedures are concluded.

7-5.1.2 Notify all personnel whose operations may be affected by the system operation.

7-5.1.3 The owner's representative, the authority having jurisdiction, and the fire department or fire brigade shall be notified that testing will be conducted so they may have the opportunity of observing the inspection and testing of the water spray systems.

7-5.2 Test Preparation. Care shall be taken to prevent water damage by verifying there is adequate drainage. Protection shall be provided for any devices that may be damaged during tests by the discharge from nozzles or water runoff.

7-5.3 Operation Test Performance. Operation tests shall be conducted to ensure that the water spray system(s) will respond as designed, both automatically and manually. The test procedures shall simulate, whenever possible, anticipated emergency events, so the response of the water spray system(s) can be evaluated.

7-5.3.1* Response Time. Under test conditions, the heat detection systems, when exposed to a heat test source, shall operate within 40 sec. Under test conditions, the flammable gas detection system, when exposed to a standard test gas concentration, shall operate within 20 sec. These times shall be recorded.

7-5.3.2 Discharge Time. The time lapse between operation of detection systems and water delivery time to the protected item shall be recorded.

7-5.3.3 The water discharge patterns from all of the spray nozzles shall be observed to ensure that patterns are not impeded by plugging of the nozzles and to ensure that nozzles are properly positioned and that their discharge patterns are not obstructed from effectively wetting surfaces to be protected. When obstructions occur, the piping and nozzles shall be cleaned and the system retested. These nozzles may be of different orifice sizes and types. Some nozzles may be more subject to internal obstruction than others.

7-5.3.4 Pressure readings shall be recorded at the hydraulically most remote nozzle to ensure the waterflow has not been impeded by partially closed valves or by plugged strainers or piping. A second pressure reading shall be recorded at the deluge valve to ensure the water supply is adequate. These readings shall be compared to the hydraulic design pressures to ensure the original system design is met and the water supply is adequate to meet the design requirements.

Exception: When the hydraulically most remote nozzle is inaccessible, nozzles shall be permitted to be visually checked without taking a pressure reading on the most remote nozzle. However, when the reading taken at the riser indicates that the water supply has deteriorated, a gauge shall be placed on the hydraulically most remote nozzle and the results compared with the required design pressure.

7-5.4 Multiple Systems. The maximum number of systems expected to operate in case of fire shall be tested simultaneously to check the adequacy of the water supply.

7-5.5 Manual Operation. Manual actuation devices shall be operated at least annually.

7-5.6 Return to Service. After the full flow test, the water spray system shall be maintained and returned to service in accordance with the manufacturer's instructions.

7-5.6.1 Main drain tests shall be conducted at the main riser to determine whether there has been any change in the condition of the water supply piping and controlling valves. Static and residual water pressures shall be recorded respectively before, during, and after the operation of the fully opened drain valve. Comparisons shall be made of these readings with those made at the time of the original acceptance tests or with those made at the time of the last test to determine if there has been any deterioration of the water supply.

7-5.6.2 To prevent freezing and corrosion, all low point drains in aboveground piping shall be opened, the pipe properly drained, and the valves closed and plugs replaced. Where weep holes are provided in lieu of low point drains, they shall be inspected to ensure they are clear and unobstructed.

7-6 Records. See Chapter 1 for record keeping and reporting procedures.

Chapter 8 Foam-Water Sprinkler Systems

8-1 General.

8-1.1 Foam-Water Systems. This section covers foam-water systems as specified in NFPA 16, *Standard on the Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems*, and NFPA 16A, *Recommended Practice for the Installation of Closed-Head Foam-Water Sprinkler Systems*. This section does not include systems detailed in NFPA 11, *Standard for Low Expansion Foam and Combined Agent Systems*.

8-1.2 General Information. This chapter provides the minimum requirements relative to the routine inspection, testing, and maintenance of foam-water systems. See Table 8-3 for the minimum required frequencies for inspection, testing, and maintenance.

Exception: Requirements for fire pumps, water storage tanks, and valves common to other types of water-based fire protection systems are found in Chapters 5, 6, and 9, respectively, and listed in Table 8-3.

8-1.3 Foam-Water System.

8-1.3.1 A foam-water system is comprised of a water supply source, a control valve(s), a proportioner(s), a foam concentrate supply, and a discharge device(s).

8-1.3.2 If during routine inspection and testing it is determined that the foam-water system has been altered or changed (e.g., equipment replaced, relocated, or foam concentrate replaced), it shall be determined that the design intent has not been altered and the system will operate properly. The inspection shall verify that all components, including foam concentrate discharge devices and proportioning equipment, are installed or provided in accordance with their listing.

8-1.4 Proportioning System. The proportioning system can be any of the following types:

(a) Standard pressure proportioner
(b) Bladder tank proportioner
(c) Line proportioner (venturi pick-up)
(d) Standard balanced pressure proportioner
(e) In-line balanced pressure proportioner
(f) Orifice plate either direct or indirect
(g) Other approved proportioning method.

8-1.5 Impairments. The inspection, testing, and maintenance of foam-water systems may involve or result in a system being out of service. The procedures outlined in Chapter 10 of this standard shall be followed when such an impairment to protection occurs.

8-1.6 Notification to Supervisory Service. To avoid false alarms where supervisory service is provided, the alarm receiving facilities shall always be notified by the owner or

designated representative (1) before conducting any test or procedure which could result in the activation of an alarm, and (2) after such tests or procedures are concluded.

8-2 Definitions. The definitions specified herein are typical for the system described. The illustrations shown are general configurations and may vary from system to system depending upon specific requirements.

Standard Pressure Proportioner. This type of system uses a pressure vessel containing foam concentrate. Water is supplied to the proportioner, which directs an amount of the supply downward onto the contained concentrate, thereby pressurizing the tank. Pressurized concentrate is then forced through an orifice back into the flowing water stream. This type of system is applicable for use with foam concentrates having a specific gravity substantially higher than water. It is not applicable for use with foam concentrates with a specific gravity at or near that of water.

Bladder Tank Proportioner. Similar to a standard pressure proportioner, except the foam concentrate is contained inside a diaphragm bag contained inside a pressure vessel. Operation is the same as a standard pressure proportioner, except, because of the separation of the foam concentrate and water, these are applicable for all foam concentrates regardless of specific gravity.

Line Proportioner. This system uses a venturi pick-up type device where water passing through the unit creates a vacuum, thereby allowing foam concentrate to be picked up from an atmospheric storage container.

Standard Balanced Pressure Proportioner. This type of system utilizes a foam concentrate pump. Foam concentrate is drawn from an atmospheric storage tank, is pressurized by the pump, and passes back through a diaphragm balancing valve to the storage tank. Water and foam concentrate sensing lines are directed to the balancing valve and maintain the foam liquid pressure equal to that of the water pressure. The two equal pressures are fed to the proportioner proper and are mixed at a predetermined rate.

In-Line Balanced Pressure Proportioner. This system is similar to a standard balanced pressure system, except the pumped concentrate pressure is maintained at a fixed preset value. Balancing of water and liquid takes place at individual proportioners located in system riser or segments of multiple systems.

Orifice Plate Proportioning. This system utilizes an orifice plate(s) through which passes a specific amount of foam concentrate at a specific pressure drop across the orifice plate(s).

Foam Discharge Device. Any device that when fed with a foam-water solution will produce foam. These devices may be nonair-aspirating such as: sprinklers, water nozzles, etc., or air-aspirating such as: foam-water sprinklers, directional foam-water nozzles, foam nozzles, etc. They all discharge a special pattern of distribution peculiar to the particular device.

Pressure Vacuum Vent. A venting device mounted on atmospheric foam concentrate storage vessels to allow for concentrate expansion and contraction and for tank breathing during concentrate discharge or filling. At rest (static condition), this device is closed to prevent free breathing of the foam concentrate storage tank.

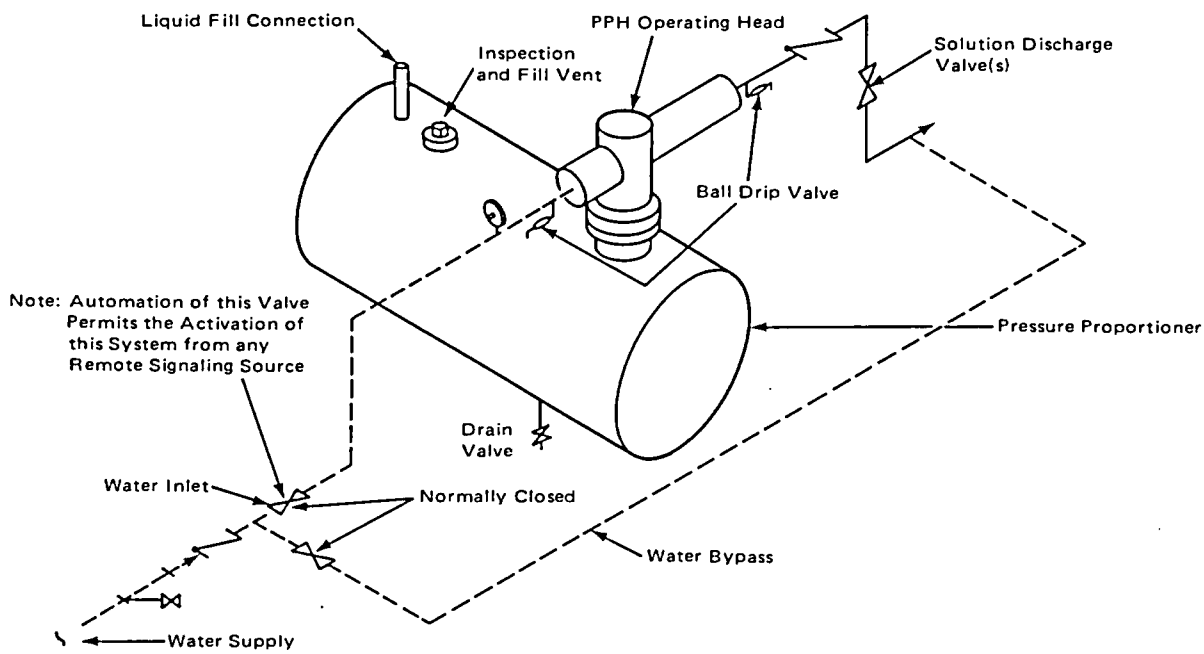
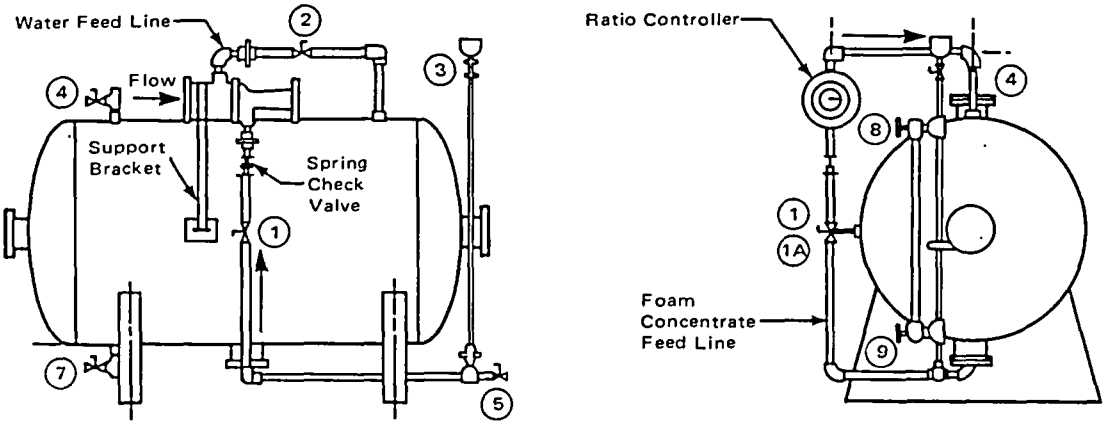


Figure 8-2(a) Standard pressure proportioner.



Valve Description		Normal Position	
Valve No.	Description	Manual System	Auto System
1	Concentrate Shutoff	Closed	Open
1A	Auto. Conc. Shutoff	————	Closed
2	Water Pres. Shutoff	Open	Open
3	Fill Cup Shutoff	Closed	Closed
4	Tank Water Vent	Closed	Closed
5	Diaph. Conc. Vent	Closed	Closed
6	Water Drain/Fill	Closed	Closed
7	Concentrate Drain/Fill	Closed	Closed
8	Upr. Sight Gauge (Opt.)	Closed	Closed
9	Lwr. Sight Gauge (Opt.)	Closed	Closed

Figure 8-2(b) Bladder tank proportioner.

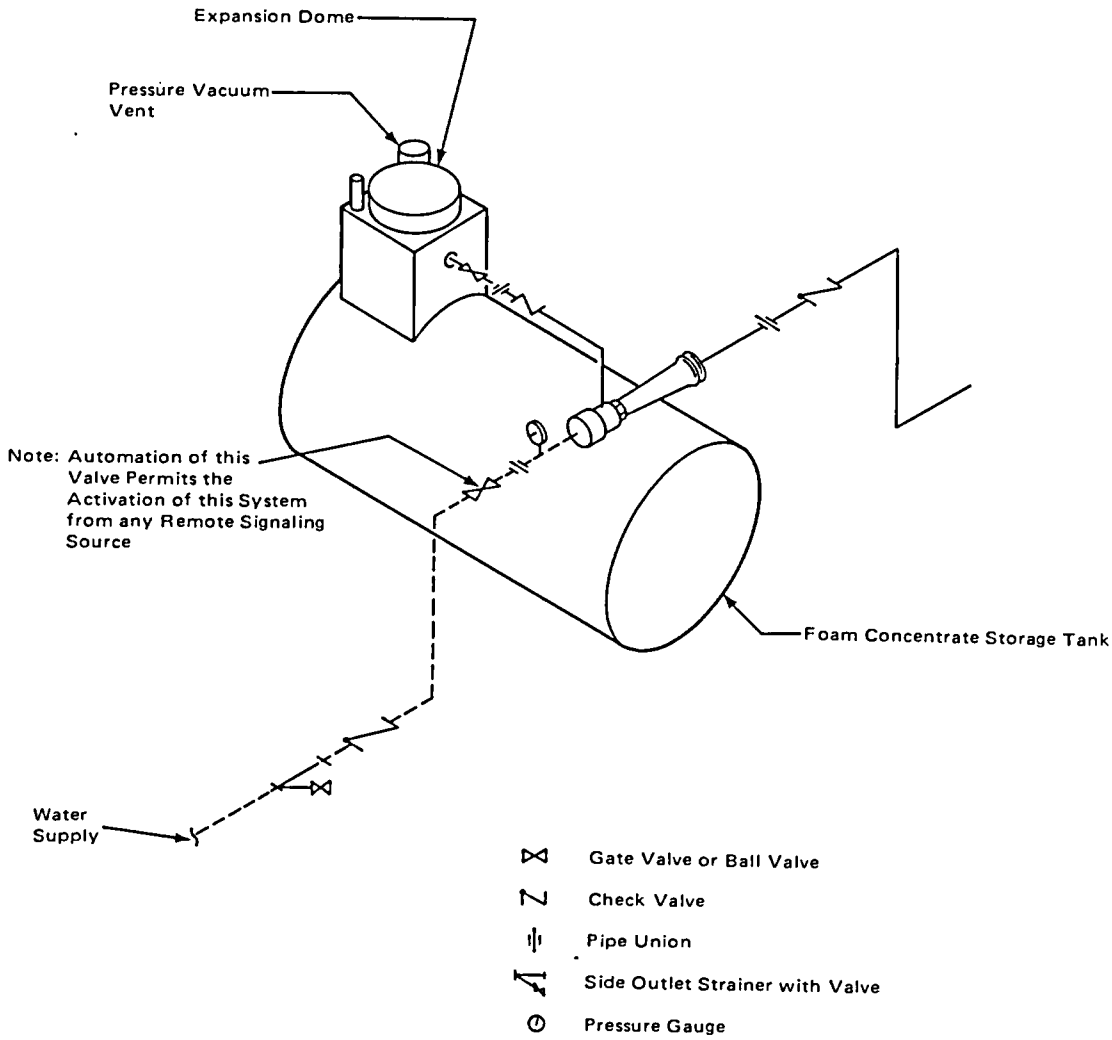


Figure 8-2(c)1 Line proportioner.

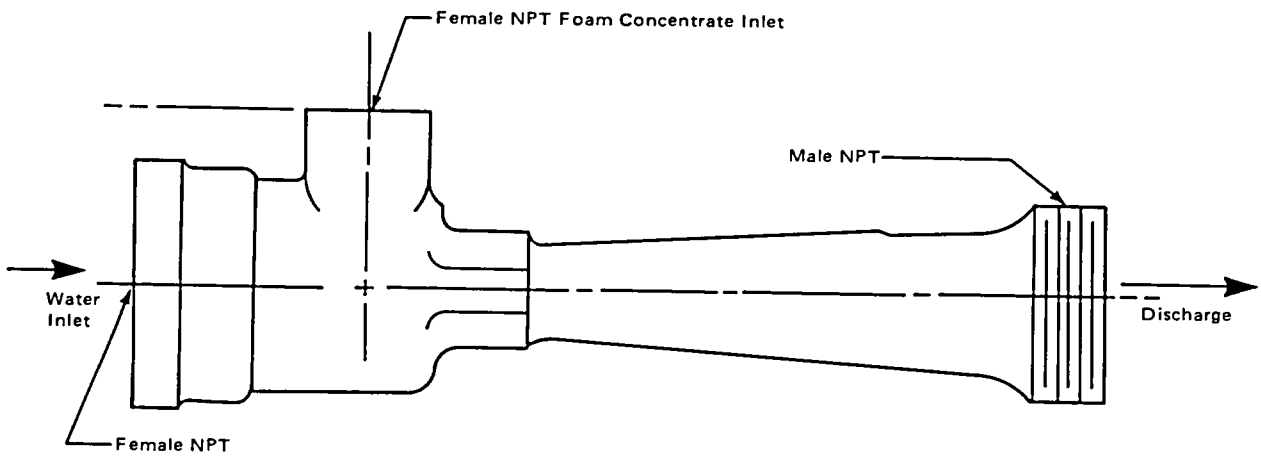
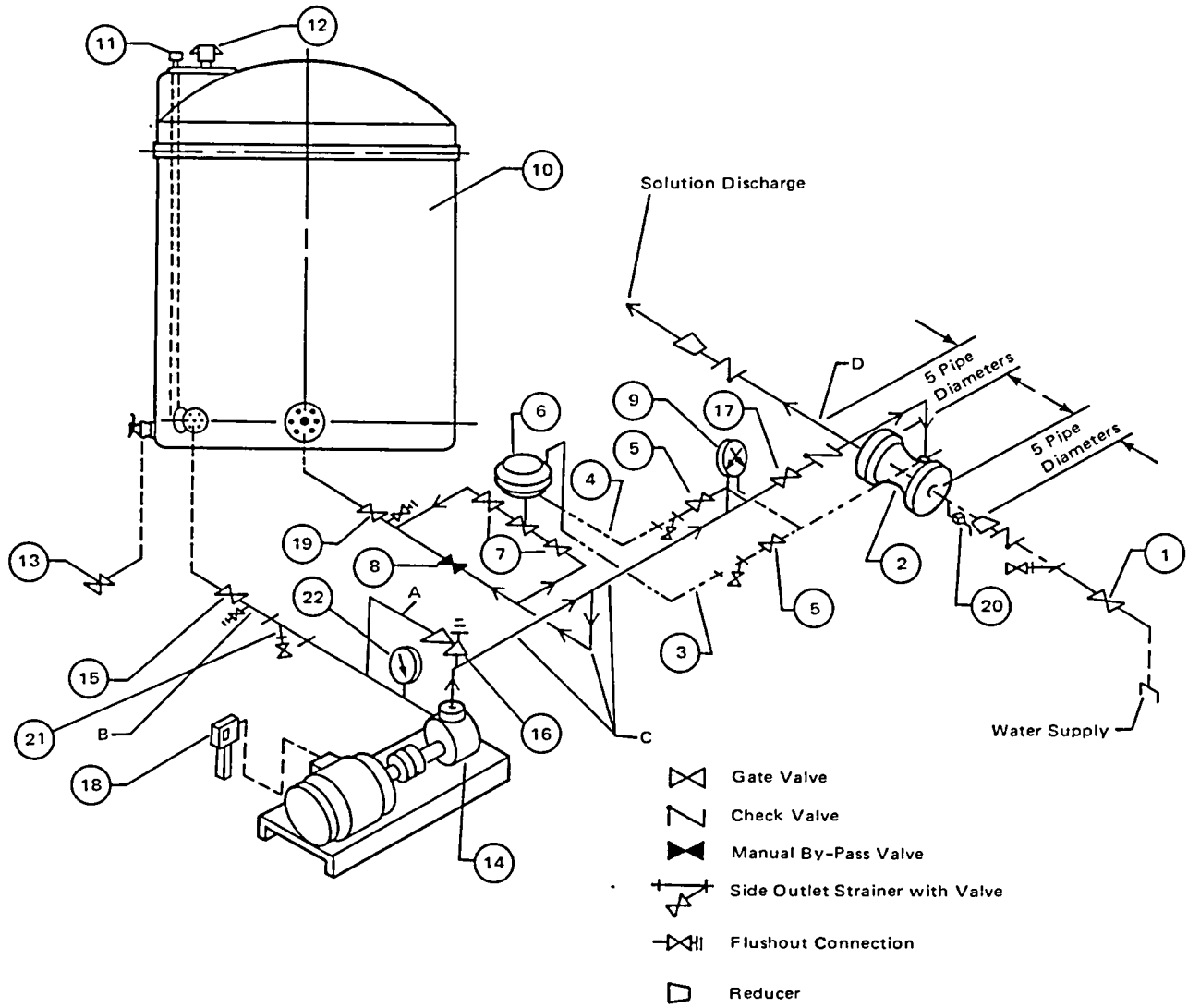


Figure 8-2(c)2 Proportioner.



Legend:
1. Water supply valve (normally closed)
2. Ratio controller
3. Water balance line — minimum 3/16" I.D. pipe or tubing recommended
4. Concentrate balance line — minimum 3/16" I.D. pipe or tubing recommended
5. Sensing line valves (normally open)
6. Diaphragm control valve — automatic pressure balance — must be in vertical position
7. Block valves (normally open)
8. Manual by-pass valve (normally open)
9. Water and concentrate pressure gauge (duplex)
10. Foam concentrate storage tank
11. Concentrate storage tank fill connection
12. Pressure-vacuum vent
13. Concentrate storage tank drain valve (normally closed)
14. Foam concentrate-pump and motor
15. Concentrate-pump supply valve (normally open)
16. Pressure relief valve (setting as required by system)
17. Concentrate-pump discharge valve (normally open)
18. Electric motor starter and switch
19. Concentrate return line valve (normally open)
20. Ball drip valve, 3/4" (install in horizontal position)
21. Strainer, with valved side outlet
22. Compound gauge

Operation:
Start concentrate pump (18). Open water supply valve (1): then open concentrate pump discharge valve (17). Equal gauge readings will then be maintained at (9) by the automatic valve (6). For manual operation, valves (7) can be closed and equal gauge readings maintained by regulating valve (8) manually.

System Automation:
By automating certain valves, the Balanced Pressure Proportioning System can be activated from any remote signaling source.

- valve (1), normally closed, to be automatically operated;
- valve (17), normally closed, to be automatically operated;
- electric motor starter switch (18) to be automatically operated.

Figure 8-2(d) Standard balanced pressure proportioner.

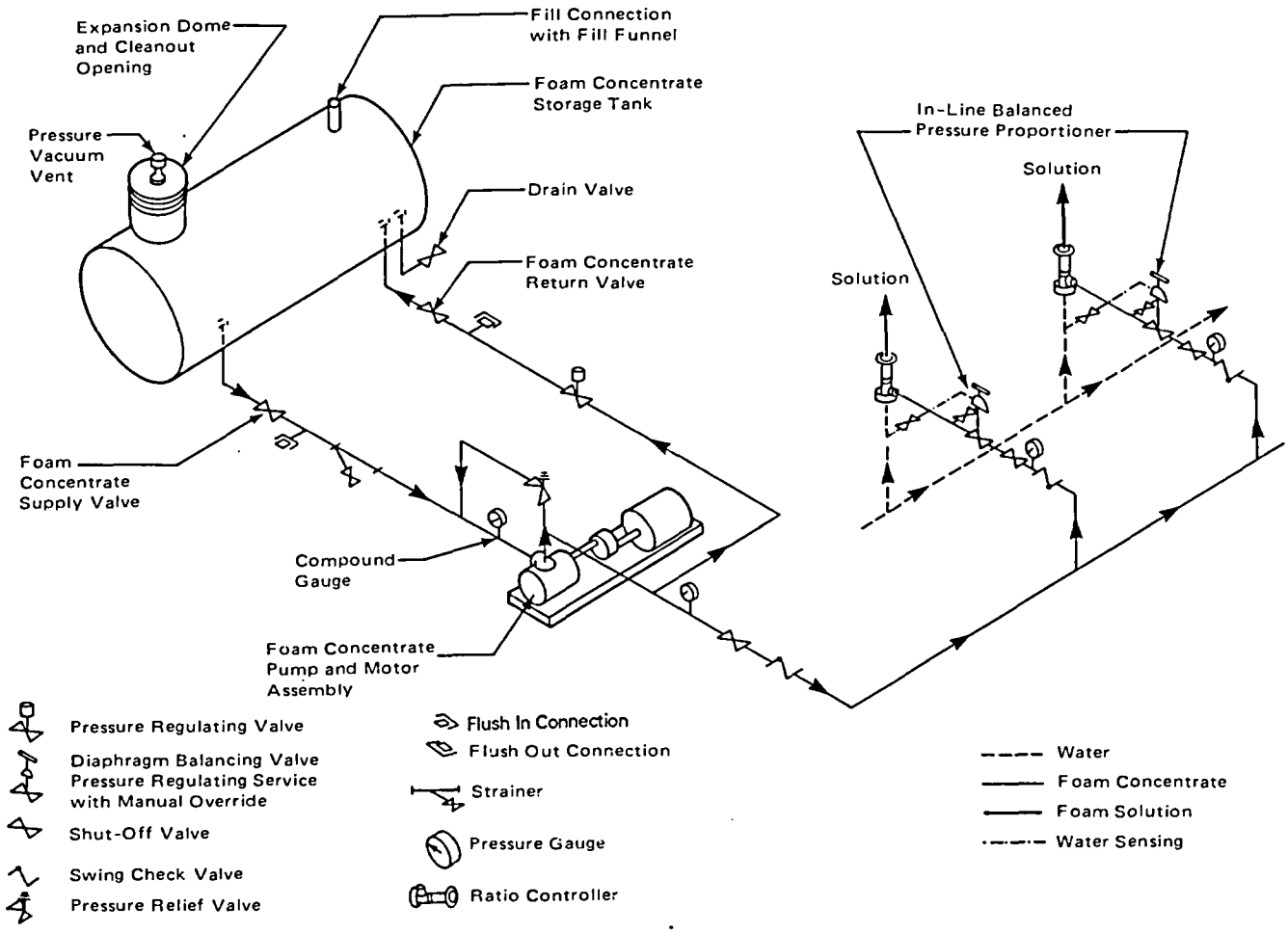


Figure 8-2(e) In-line balanced pressure proportioner.

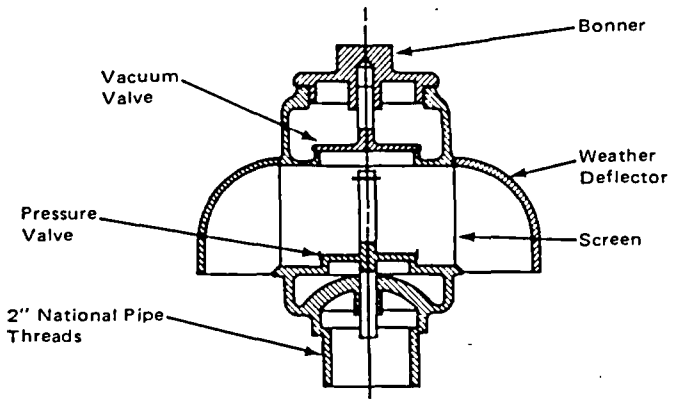


Figure 8-2(f) Vacuum vent.

8-3 Inspection. Foam-water systems require competent and effective inspection to ensure they will perform effectively. Systems shall be inspected in accordance with the frequency as specified in Table 8-3.

8-3.1 Deluge Valves. Deluge valves shall be inspected in accordance with the provisions of Chapter 9.

8-3.2 Automatic Detection Equipment. Automatic detection equipment shall be inspected, tested, and maintained in accordance with NFPA 72E, *Standard on Automatic Fire Detectors*, to ensure the detectors are properly located, in place, securely fastened, and protected from corrosion, weather, and mechanical damage and the communication wiring, control panels, or pneumatic tubing system is functional.

8-3.3 System Piping and Fittings. System piping and fittings shall be visually inspected for the following:

(a) Mechanical damage (e.g., broken piping or cracked fittings).

(b) External conditions (e.g., missing or damaged paint or coatings, rust, and corrosion).

(c) Misalignment or trapped sections.

(d) Low point drains (automatic or manual).

(e) Location and condition of rubber gasketed fittings.

8-3.3.1 Hangers and Supports. Hangers and supports shall be visually inspected for the following:

(a) Condition (e.g., missing or damaged paint or coating, rust, and corrosion).

(b) Secure attachment to structural supports and piping.

(c) Damaged or missing hangers.

8-3.4 Foam-Water Discharge Devices. Foam-water discharge devices shall be visually inspected and maintained to ensure that they are in place, continue to be aimed or pointed in the direction intended in the system design, and are free from external loading and corrosion. Where caps or plugs are required, the inspection shall confirm they are in place and free to operate as intended.

8-3.4.1 Misaligned Discharge Devices. They shall be adjusted (aimed) by visual means, and the discharge patterns shall be checked at the next scheduled flow test.

8-3.4.2 Discharge Devices. These are listed or approved with particular foam concentrates. Inspection shall verify that unlisted combinations of discharge devices and foam concentrate have not been substituted.

8-3.5 Water Supply.

8-3.5.1 The dependability of the water supply shall be ensured by regular inspection and maintenance whether furnished by municipal source, on-site storage tanks, fire pump, or private underground piping systems.

8-3.5.2 Water supply piping shall be maintained free of internal obstruction, which may be caused by debris (e.g., rocks, mud, tubercles) or by closed or partially closed control valves. See Chapter 4 for inspection and maintenance requirements.

8-3.6 Control Valves.

8-3.6.1 All control valves of a foam-water sprinkler system shall be inspected at regular intervals as follows:

(a) Sealed valves — weekly.

(b) Locked valves and valves with tamper switches — monthly.

Valves shall be maintained as mandated in Chapter 9.

8-3.6.2 If a valve is found closed, the reason for the closure shall be thoroughly investigated. The valve shall be reopened and the system returned to service as quickly as possible.

8-3.7 Other Devices. Other devices, such as check valves, detector check valves, and back flow preventers, that are installed in the water supply piping system shall be inspected and maintained so that they do not impede the flow of water and fire main pressure. See Chapter 9 for inspection and maintenance requirements.

8-3.8 Strainers.

8-3.8.1 Mainline and individual discharge device strainers (basket or screen) shall be inspected in accordance with the provisions of Chapter 7.

8-3.8.2 Foam concentrate strainers shall be inspected visually to ensure blow-down valve is closed and plugged. Baskets or screens shall be removed and inspected after each operation or flow test.

8-3.9 Drainage. The area beneath and surrounding a foam-water spray system shall be visually inspected to determine that drainage facilities such as trap sumps and drainage trenches are not blocked and retention embankments or dikes are in good repair.

8-3.10* Proportioning Systems. The component parts of various proportioning systems listed below shall be inspected in accordance with the frequency as specified in Table 8-3. Valves specified to be checked may be open or closed depending upon specific functions within each foam-water system.

8-3.10.1 Valves shall be verified as to position (open or closed) in accordance with specified operating conditions.

8-3.10.2* Concentrate tank full inspection requires that there shall be adequate foam concentrate to satisfy the requirements of the original design.

8-3.10.3 Additional inspection requirements shall be performed as detailed for the following proportioning systems.

8-3.10.3.1* Standard Pressure Proportioner. This is a pressure vessel. To prevent injury, remove pressure before inspection. Inspection shall determine if:

(a) Ball drip valves (automatic drains) are free and opened.

(b) External corrosion on foam concentrate storage tanks is not present.

Table 8-3 Inspection, Test, and Maintenance Frequency

System/Component	Activity	Frequency	Section Number
Discharge Device Location	Inspection	Monthly	8-3.4
Discharge Device Position	Inspection	Monthly	8-3.4
Discharge Device Obstruction	Inspection	Monthly	8-3.4
Foam Concentrate Strainer(s)	Inspection	Monthly	8-3.8.2
Drainage in System Area	Inspection	Monthly	8-3.9
Proportioning System(s)—All	Inspection	Monthly	8-3.10
Foam Concentrate Pump—Power	Inspection	Monthly	8-3.10.3
Pipe Corrosion	Inspection	Quarterly	8-3.3
Pipe Damage	Inspection	Quarterly	8-3.3
Fittings Corrosion	Inspection	Quarterly	8-3.3
Fittings Damage	Inspection	Quarterly	8-3.3
Hangers/Supports	Inspection	Quarterly	8-3.3.1
Water Supply Tank(s)	Inspection	See Chapter 6	—
Fire Pump(s)	Inspection	See Chapter 5	—
Water Supply Piping	Inspection	See Chapter 4	8-3.5.1
Control Valve(s)	Inspection	See Chapter 9	8-3.6
Deluge/Preaction Valve(s)	Inspection	See Chapter 9	8-3.1
Detection System	Inspection	See NFPA 72E	8-3.2
Discharge Device Location	Test	Annually	8-4.3.3
Discharge Device Position	Test	Annually	8-4.3.3
Discharge Device Obstruction	Test	Annually	8-4.3.3
Foam Concentrate Strainer(s)	Test	Annually	8-3.8.2
Proportioning System(s)—All	Test	Annually	8-4.3
Complete Foam-Water System(s)	Test	Annually	8-4.3
Foam-Water Concentrate	Test	Annually	8-4.6
Manual Actuation Device(s)	Test	Annually	8-4.5
Backflow Device	Test	Annually	8-3.7
Fire Pump(s)	Test	See Chapter 5	—
Water Supply Piping	Test	See Chapter 4	8-3.5.1
Control Valve(s)	Test	See Chapter 9	8-3.6
Strainer(s)—Mainline	Test	See Chapter 7	8-3.8
Deluge/Preaction Valve(s)	Test	See Chapter 9	8-3.1
Detection System	Test	See NFPA 72E	8-4.3.1
Backflow Preventer	Test	See Chapter 9	8-3.7
Water Supply Tank(s)	Test	See Chapter 6	—
Water Supply Flow Test	Test	See Chapter 4	8-3.5
Foam Concentrate Pump Running	Maintenance	Monthly	8-5.4(a)/ 8-5.5(a)
Foam Concentrate Strainer(s)	Maintenance	Monthly	8-5
Foam Concentrate Samples	Maintenance	Annually	8-3.11
Proportioning System(s)			
Standard Pressure Type			
Ball Drain (Automatic Type)			
Drain Valves	Maintenance	5 Years	8-5.1(a)
Foam Concentrate Tank—			
Drain and Flush	Maintenance	10 Years	8-5.1(b)
Internal Corrosion & Hydro.	Maintenance	10 years	8-5.1(c)
Bladder Tank Type			
Sight Glass	Maintenance	10 Years	8-5.2(a)
Foam Concentrate Tank—Hydro	Maintance	10 Years	8-5.2(b)
Line Type			
Foam Concentrate Tank—			
Corrosion and Pickup Pipes	Maintenance	10 Years	8-5.3(a)
Foam Concentrate Tank—			
Drain and Flush	Maintenance	10 Years	8-5.3(b)
Standard Balance Pressure Type			
Foam Concentrate Pump(s)	Maintenance	5 Years (see Note 1)	8-5.4(b)
Balancing Valve Diaphragm	Maintenance	5 Years	8-5.4(c)
Foam Concentrate Tank	Maintenance	10 Years	8-5.4(d)
In-Line Balance Pressure Type			
Foam Concentrate Pump(s)	Maintenance	5 Years (see Note 1)	8-5.5(b)
Balancing Valve Diaphragm	Maintenance	5 Years	8-5.5(c)
Foam Concentrate Tank	Maintenance	10 Years	8-5.5(d)
Water Supply Tank(s)	Maintenance	See Chapter 6	—
Fire Pump(s)	Maintenance	See Chapter 5	—
Water Supply Piping	Maintenance	See Chapter 4	8-3.5.1
Backflow Preventer(s)	Maintenance	See Chapter 9	8-3.7
Detector Check Valve(s)	Maintenance	See Chapter 9	8-3.7
Check Valve(s)	Maintenance	See Chapter 9	8-3.7
Control Valve(s)	Maintenance	See Chapter 9	8-3.6
Deluge/Preaction Valves	Maintenance	See Chapter 9	8-3.1
Strainer(s)—Mainline	Maintenance	See Chapter 9	8-3.8
Detection System	Maintenance	See NFPA 72E	8-3.2

Note 1: Also refer to manufacturer's instructions and frequency.
Maintenance intervals other than preventive maintenance are not given, as they depend on the results of the visual inspections and operational tests.
For foam-water systems in aircraft hangars refer to inspection, test, and maintenance requirements in NFPA 409, Table 6-1.1.

8-3.10.3.2* Bladder Tank Proportioner. This is a pressure vessel. Inspection shall check:

(a) Water control valves to foam concentrate tank.

(b) External corrosion on foam concentrate storage tanks.

8-3.10.3.3 Line Proportioner. Inspection shall check:

(a) Strainers (*see 8-3.8.1*).

(b) Pressure vacuum vent is operating freely [*see Figure 8-2(f)*].

(c) External corrosion on foam concentrate storage tanks.

8-3.10.3.4 Standard Balanced Pressure Proportioner. Inspection shall check:

(a) Strainers (*see 8-3.8.1*).

(b) Pressure vacuum vent is operating freely [*see Figure 8-2(f)*].

(c) Gauges are in good operating condition.

(d) Sensing line valves are open.

(e) Power is available to foam liquid pump.

8-3.10.3.5 In-Line Balanced Pressure Proportioner. Inspection shall check:

(a) Strainers (*see 8-3.8.1*).

(b) Pressure vacuum vent is operating freely [*see Figure 8-2(f)*].

(c) Gauges at pump unit and individual proportioner.

(d) Sensing line valves at pump unit and individual proportioner stations are open.

(e) Power is available to foam liquid pump.

8-3.10.3.6 Orifice Plate Proportioner. Inspection shall check:

(a) Strainers (*see 8-3.8.1*).

(b) Pressure vacuum vent is operating freely [*see Figure 8-2(f)*].

(c) Gauges are in good working condition.

(d) Power is available to foam liquid pump.

8-3.11 Foam Concentrate Samples. Samples shall be submitted in accordance with the manufacturer's recommended sampling procedures.

8-4* Operational Tests. Foam-water systems require competent and effective care and testing to ensure they will perform effectively. Frequency of system tests shall be in accordance with Table 8-3.

Exception: Systems installed in accordance with NFPA 409, Standard on Aircraft Hangars. Refer to this standard for the frequency of operational tests.

8-4.1 Owner's Representative. The owner's representative, the authority having jurisdiction, and the fire department or fire brigade shall be notified that testing will be conducted so they may have the opportunity of observing the testing of the foam water systems.

8-4.2 Test Preparation. Care shall be taken to prevent damage by verifying there is adequate drainage. Protection shall be provided for any devices that may be damaged during tests by the discharge of the system or runoff.

8-4.3* Operation Test Performance. Operation tests shall be conducted to ensure that the foam-water system(s) will respond as designed, both automatically and manually. The test procedures shall simulate, wherever possible, anticipated emergency events so the response of the foam water system(s) can be evaluated.

Exception: Where discharge from the system discharge devices will create a hazardous condition or conflict with local requirements, an approved alternate method to achieve full flow conditions shall be acceptable.

8-4.3.1 Response Time. Under test conditions the automatic fire detection systems, when exposed to a test source, shall operate within the requirements of NFPA 72E, *Standard on Automatic Fire Detectors*, for the type of detector provided. This time shall be recorded.

8-4.3.2 Discharge Time. The time lapse between operation of detection systems and water delivery time to the protected area shall be recorded.

Exception: Closed sprinkler foam-water sprinkler systems.

8-4.3.3 Discharge Patterns. The discharge patterns from all of the discharge devices shall be observed to ensure that patterns are not impeded by plugging of the discharge devices and to ensure that discharge devices are properly positioned and that obstructions do not prevent discharge patterns from effectively covering surfaces to be protected. When obstructions occur, the piping and discharge devices shall be cleaned and the system retested. These discharge devices may be of different orifice sizes and types. Some discharge devices may be more subject to internal obstruction than others.

Exception: Closed sprinkler foam-water systems.

8-4.3.4* Pressure Readings. Pressure readings shall be recorded at the highest, most remote discharge device to ensure solution flow has not been impeded by partially closed valves or by plugged strainers or piping. A second pressure reading shall be recorded at the main control valve to ensure the water supply is adequate. These readings shall be compared to the hydraulic design pressures to ensure the original system design is met and the water supply is adequate to meet the design requirements.

8-4.4 Multiple Systems. The maximum number of systems expected to operate in case of fire shall be tested simultaneously to check the adequacy of the water supply and concentrate pump.

8-4.5 Manual Actuation Devices. They shall be tested at least annually.

8-4.6 Concentration Testing. During the full flow foam test, a foam sample shall be taken. This sample shall be checked by refractometric or other methods to verify concentration of the solution. Concentration shall be within 10

percent of the acceptance test results but in no case more than 10 percent below minimum design standards.

8-4.7 Return to Service. After the full flow test, the foam-water system shall be returned to service and the foam concentrate tank shall be replenished to design level.

8-5* Maintenance. Maintenance of foam-water systems shall be in accordance with the requirements of the chapters covering the specific component parts. See Table 8-3 for maintenance frequencies. Maintenance of specific foam components shall be in accordance with the following.

8-5.1 Standard Pressure Proportioner.

(a) Ball drip (automatic type) drain valves shall be disassembled, cleaned, and reassembled.

(b)* The foam liquid storage tank shall be drained of foam liquid and flushed. (Foam liquid may be salvaged and reused.)

(c) The foam liquid tank shall be inspected for internal and external corrosion and hydrostatically tested to the specified working pressure.

8-5.2 Bladder Tank Proportioners.

(a) Sight glass, when provided, shall be removed and cleaned.

(b)* The foam concentrate tank shall be hydrostatically tested to the specified working pressure.

8-5.3 Line Proportioner.

(a) The foam concentrate tank shall be inspected for internal corrosion. Pick-up pipes inside the tank shall be inspected for corrosion, separation, or plugging.

(b) The foam concentrate tank shall be drained and flushed. (Foam concentrate may be salvaged and reused.)

8-5.4 Standard Balanced Pressure Proportioner.

(a) The foam concentrate pump shall be run. Foam concentrate shall be circulated back to the tank.

(b) Foam pumps, drive train, and drivers shall be serviced in accordance with manufacturer's instructions and frequency, but at least every 5 years.

(c) The balancing valve diaphragm shall be flushed through the diaphragm section with water or foam concentrate until fluid appears clear or new.

(d) The foam concentrate tank shall be inspected internally for corrosion and sedimentation. Excessive sedimentation shall require draining and flushing of the tank.

8-5.5 In-Line Balanced Pressure Proportioner.

(a) The foam concentrate pump shall be run. Foam concentrate shall be circulated back to the tank.

(b) Foam pumps, drive train, and drivers shall be serviced in accordance with manufacturer's instructions and frequency, but at least every 5 years.

(c) The balancing valve diaphragm shall be flushed through the diaphragm section with water or foam.

(d) The foam concentrate tank shall be inspected internally for corrosion and sedimentation. Excessive sedimentation shall require draining and flushing of the tank.

8-5.6 Vacuum Vents.

(a) Vent shall be removed from expansion dome. While vent is removed, it shall be ensured that the opening is not blocked and that dirt or other foreign objects do not enter the tank.

(b) Vest bonnet shall be removed. Vacuum valve and pressure valve shall be lifted out.

(c) Vent body shall be flushed internally and vacuum valve and pressure valve shall be washed thoroughly. Water shall be adequate for normal cleaning. Make sure the screen is not clogged and avoid the use of any hard pointed objects to clear screen.

(d) If liquid has become excessively gummy or solidified, vent body and parts shall be soaked in hot soapy water.

(e) Vent body shall be turned upside down and drained thoroughly. Parts shall be dried by placing them in a warm and dry area or by using an air hose.

(f) Parts shall be sprayed with a light Teflon coating and vent reassembled. Avoid the use of any type of oil for lubrication purposes as oil is harmful to the foam liquid.

(g) Vent bonnet shall be replaced and vent slowly turned upside down a few times to insure proper freedom of the movable parts.

(h) Vent shall be attached to the liquid storage tank expansion dome.

Chapter 9 Valves and Fire Department Connections

9-1* General. This chapter provides the minimum requirements relative to the routine inspection, testing, and maintenance of valves. Table 9-1 shall be used to determine the minimum required frequencies for inspection, testing, and maintenance.

9-2 General Provisions.

9-2.1 The items listed below are common to the inspection and testing of all system valves. The sequence is for reference only and may be changed to suit local conditions.

The owner shall have appropriate manufacturer's literature available to provide specific instructions for inspecting, testing, and maintaining the valves and associated equipment.

9-2.2 All pertinent personnel, departments, authorities having jurisdiction, or agencies shall be notified that testing or maintenance of the valve and associated alarms will be conducted (*see Chapter 1*).

9-2.3 All system valves shall be protected from physical damage and be accessible.

Table 9-1 Minimum Inspection, Testing and Maintenance Frequency

Component	Activity	Frequency	Section Number
Control Valve			
Sealed	Inspection	Weekly	9-3.3.1
Locked	Inspection	Monthly	9-3.3.1, Exception 1
Tamper Switch	Inspection	Monthly	9-3.3.1, Exception 1
Alarm Valve			
Exterior	Inspection	Monthly	9-4.1.1
Interior	Inspection	5 Years	9-4.1.2
Strainers, Filters, Orifices	Inspection	5 Years	9-4.1.2
Check Valve			
Interior	Inspection	5 Years	9-4.2.1
Preaction/Deluge Valve			
Enclosure (during cold weather)	Inspection	Daily/Weekly	9-4.3.1
Exterior	Inspection	Weekly	9-4.3.1, Exception
Interior	Inspection	Yearly/5 Years	9-4.3.1.3
Strainers, Filters, Orifices	Inspection	5 Years	9-4.3.1.4
Dry Pipe Valves/Quick Opening Devices			
Enclosure (during cold weather)	Inspection	Daily/Weekly	9-4.4.1.1
Exterior	Inspection	Weekly	9-4.4.1, Exception
Interior	Inspection	Annually	9-4.4.1.4
Strainers, Filters, Orifices	Inspection	5 Years	9-4.4.1.5
Pressure Regulating & Relief Valves			
Sprinkler Systems	Inspection	Monthly	9-5.1.1
Hose Connection	Inspection	Monthly	9-5.2.1
Hose Rack	Inspection	Monthly	9-5.3.1
Fire Pump			
Casing Relief Valve	Inspection	Weekly	9-5.4.1, 9-5.4.1.1
Pressure Relief Valve	Inspection	Weekly	9-5.4.2, 9-5.4.2.1
Backflow Prevention Assemblies			
Reduced Pressure	Inspection	Weekly	9-6.1.2
Reduced Pressure Detector	Inspection	Weekly	9-6.1.2
Fire Department Connections	Inspection	Monthly	9-7
Main Drain	Test	Quarterly	9-2.6
Waterflow Alarm	Test	Quarterly	9-2.7
Control Valve			
Position	Test	Quarterly	9-3.4.1
Operation	Test	Annually	9-3.4.2
Preaction/Deluge Valve			
Priming Water	Test	Quarterly	9-4.3.2.1
Low Pressure Alarms	Test	Quarterly	9-4.3.2.10
Full Flow	Test	Annually	9-4.3.2.2
Dry Pipe Valves/Quick Opening Devices			
Priming Water	Test	Quarterly	9-4.4.2.1
Low Air Pressure Alarm	Test	Quarterly	9-4.4.2.6
Quick Opening Devices	Test	Semiannually	9-4.4.2.4
Trip Test	Test	Yearly	9-4.4.2.2
Full Flow Trip Test	Test	3 years	9-4.4.2.2.1
Pressure Regulating & Relief Valves			
Sprinkler System	Test	Annually	9-5.1.2
Circulation Relief	Test	Yearly	9-5.4.1.2
Pressure Relief Valve	Test	Yearly	9-5.4.2.2
Hose Connection	Test	5 Years	9-5.2.2
Hose Rack	Test	5 Years	9-5.3.2
Backflow Prevention Assemblies	Test	Yearly	9-6.2
Control Valve	Maintenance	Yearly	9-3.5
Preaction/Deluge Valve	Maintenance	Yearly	9-4.3.3.2
Dry Pipe Valve/Quick Opening Device	Maintenance	Yearly	9-4.4.3.2

9-2.4 Before opening a test or drain valve, it shall be verified that adequate provisions have been made for drainage.

9-2.5 The general appearance and condition of all valves shall be observed and noted, and it shall be verified that all valves are in their appropriate open or closed position.

9-2.6* Main Drain Test. A main drain test shall be conducted quarterly to help determine if there has been a change in the condition of the water supply piping and control valves.

9-2.7 Waterflow Alarm. All waterflow alarms shall be tested quarterly in accordance with the manufacturer's instructions.

9-2.8 Records.

9-2.8.1 Records of each inspection, showing the date and the name of the individual or agency conducting the inspection, shall be completed and shall be available for the authority having jurisdiction.

9-2.8.2 A record showing the date of all tests, and their results, shall be completed, retained, and made available if requested by the authority having jurisdiction for comparison to the results of the original acceptance tests and previous tests.

9-3 Control Valves in Water-Based Fire Protection Systems.

9-3.1* General. The term "control valve" shall mean valves controlling flow to water-based fire protection systems.

9-3.2* Each control valve shall be identified and have a sign indicating the system or portion of the system it controls.

9-3.2.1* When a normally open valve is closed, the procedures established in Chapter 10 shall be followed.

9-3.2.2 Each valve shall be secured in its normal open or closed position by means of a seal or a lock or shall be electrically supervised in accordance with the applicable NFPA standards.

Exception: Valves controlling flow to wall and roof outlets shall not be locked.

9-3.2.3 Definitions.

Hose Valve. The control valve to an individual hose connection.

Regulating Valve. A valve designed for the purpose of reducing the downstream water pressure under both flowing and nonflowing (static) conditions.

Restricting Valve. A valve or device designed for the purpose of reducing the downstream water pressure under flowing conditions only.

9-3.3 Inspection.

9-3.3.1 All valves shall be inspected weekly.

Exception No. 1: Valves secured with locks or supervised in accordance with applicable NFPA standards shall be permitted to be inspected monthly.

Exception No. 2: After any alterations or repairs, an inspection shall be made by the owner to ensure that the system is in service and all valves are in the normal position and properly sealed, locked, or electrically supervised.

9-3.3.2* The valve inspection shall verify that the valves are:

(a) In the normal open or closed position.

(b)* Properly sealed, locked, or supervised.

(c) Accessible.

(d) Provided with appropriate wrenches.

(e) Free from external leaks.

(f) Provided with appropriate identification.

9-3.4 Testing.

9-3.4.1 Quarterly, each control valve shall be opened until spring or torsion is felt in the rod, indicating that the rod has not become detached from the valve. Valves shall be backed one-quarter turn from the wide open position to prevent jamming.

Exception: Testing shall not be required for outside screw and yoke valves or gear-operated indicating butterfly valves.

9-3.4.2* Annually, each control valve shall be operated through its full range and returned to its normal position.

9-3.5 Maintenance. The operating stems of outside screw and yoke valves shall be lubricated annually. The valve shall then be completely closed and reopened to test its operation and distribute the lubricant.

9-4 System Valves.

9-4.1 Alarm Valves.

9-4.1.1* Inspection. Alarm valves shall be inspected monthly. The valve inspection shall verify that:

(a) Gauges indicate normal supply water pressure being maintained.

(b) The valve is free of physical damage.

(c) All valves are in their appropriate open or closed position.

(d) There is no leakage from the retarding chamber or alarm drains.

9-4.1.2* Alarm valves and their associated strainers, filters, and restriction orifices shall be inspected internally at least every five years unless tests indicate a more stringent frequency is required.

9-4.1.3 Maintenance.

9-4.1.3.1 Internal components shall be cleaned/repaired as necessary in accordance with the manufacturer's instructions.

9-4.1.3.2 The system shall be returned to service in accordance with the manufacturer's instructions.

9-4.2 Check Valves.

9-4.2.1 Inspection. Valves shall be internally inspected at least every five years to verify that all components operate properly, move freely, and are in good condition.

9-4.2.2 Maintenance. Internal components shall be cleaned, repaired, or replaced as necessary in accordance with the manufacturer's instructions.

9-4.3 Preaction Valves and Deluge Valves.

9-4.3.1 Inspection. Valve enclosure heating equipment for preaction and deluge valves subject to freezing shall be inspected daily during cold weather for their ability to maintain a minimum temperature of at least 40°F (4°C).

Exception: Valve enclosures equipped with low temperature alarms shall be inspected weekly.

9-4.3.1.1 Gauges shall be inspected weekly. The gauge on the supply side of the preaction or deluge valve shall indicate that the normal supply water pressure is being maintained.

Exception No. 1: The gauge monitoring the preaction system supervisory air pressure, if provided, shall be inspected monthly to indicate that the normal pressure is being maintained.

Exception No. 2: The gauge monitoring the detection system pressure, if provided, shall be tested monthly to indicate that normal pressure is being maintained.

9-4.3.1.2 The preaction or deluge valve shall be inspected weekly to ascertain that:

(a) The valve is free from physical damage.

(b) All trim valves are in their appropriate open or closed position.

(c) There is no leakage from the valve seat.

(d) Electrical components are in service.

9-4.3.1.3 The interior of the preaction or deluge valve and the condition of detection devices shall be inspected annually when the trip test is conducted.

Exception: Internal inspection of valves that can be reset without removal of a faceplate shall be permitted to be conducted every five years.

9-4.3.1.4 Strainers, filters, restricted orifices, and diaphragm chambers shall be inspected internally every five years unless tests indicate a more stringent frequency is required.

9-4.3.2 Testing.

9-4.3.2.1* Priming water level in supervised preaction systems shall be tested quarterly for compliance with the manufacturer's instructions.

9-4.3.2.2* Each deluge or preaction valve shall be full flow trip tested annually in warm weather in accordance with manufacturer's instructions. When testing deluge systems, care shall be taken to prevent water damage by verifying that there is adequate drainage. Protection shall be provided for any devices or equipment subject to damage by system discharge during tests.

Exception No. 1: When the nature of the protected property is such that deluge valve water cannot be discharged for test purposes, the trip test shall be conducted in a manner that will not require discharge in the protected area.

Exception No. 2: When the nature of the protected property is such that water cannot be discharged unless protected equipment is shut down (e.g., energized electrical equipment), a full flow system test shall be conducted at the next scheduled shutdown. In all cases, the test frequency shall not exceed 3 years.

9-4.3.2.3 The water discharge patterns from all open sprinklers or spray nozzles shall be observed to ensure that patterns are not impeded by plugging and to ensure that they are properly positioned and that obstructions do not prevent discharge patterns from effectively wetting surfaces to be protected. When obstructions occur, the piping and sprinklers or nozzles shall be cleaned and the system retested.

9-4.3.2.4 Pressure readings shall be recorded at the hydraulically most remote nozzle or sprinkler to ensure the waterflow has not been impeded by partially closed valves or by plugged strainers or piping. A second pressure reading shall be recorded at the deluge valve to ensure the water supply is adequate. These readings shall be compared to the hydraulic design pressures to ensure the original system design is met and the water supply is adequate to meet the design requirements.

Exception: When the hydraulically most remote nozzle or sprinkler is inaccessible, nozzles or sprinklers in other than foam-water systems shall be permitted to be visually checked without taking a pressure reading on the most remote nozzle or sprinkler. However, when the reading taken at the riser indicates that the water supply has deteriorated, a gauge shall be placed on the hydraulically most remote nozzle or sprinkler and the result compared with the required design pressure.

9-4.3.2.5 Multiple System. The maximum number of systems expected to operate in case of fire shall be tested simultaneously to check the adequacy of the water supply.

9-4.3.2.6 Manual actuation devices shall be operated at least annually.

9-4.3.2.7 Return to Service. After the full flow test, the system shall be returned to service in accordance with the manufacturer's instructions.

9-4.3.2.8 Grease or other sealing materials shall not be applied to the seating surfaces of preaction or deluge valves.

9-4.3.2.9* Records indicating the date the preaction or deluge valve was last tripped, the tripping time, as well as the individual and organization conducting the test shall be maintained at a location or in a manner readily available for review by the authority having jurisdiction.

9-4.3.2.10 Low air pressure alarms, if provided, shall be tested quarterly in accordance with the manufacturer's instructions.

9-4.3.2.11 Automatic air pressure maintenance devices, if provided, shall be tested yearly at the time of the annual preaction or deluge valve trip test, in accordance with the manufacturer's instructions.

9-4.3.3 Maintenance.

9-4.3.3.1 Leaks causing drops in supervisory pressure sufficient to sound warning alarms and electrical malfunctions causing alarms to sound shall be located and repaired.

9-4.3.3.2 During the annual trip test the interior of the preaction or deluge valve shall be thoroughly cleaned and parts replaced or repaired as necessary.

9-4.3.3.3* Low points in preaction or deluge systems shall be drained after each operation and before the onset of freezing weather conditions.

9-4.3.3.4 Additional maintenance as required by manufacturer's instructions shall be provided.

9-4.4 Dry Pipe Vales/Quick Opening Devices.

9-4.4.1 Inspection.

9-4.4.1.1 Valve enclosure heating equipment shall be inspected daily during cold weather for its ability to maintain a minimum temperature of at least 40°F (4°C).

Exception: Valve enclosures equipped with low temperature alarms shall be inspected weekly.

9-4.4.1.2 Gauges shall be inspected weekly.

(a) The gauge on the supply side of the dry pipe valve shall indicate that the normal supply water pressure is being maintained.

(b) The gauge on the system side of the dry pipe valve shall indicate that the proper ratio of air or nitrogen pressure to water supply pressure is being maintained in accordance with the manufacturer's instructions.

(c)* The gauge on the quick opening device, if installed, shall indicate the same pressure as the gauge on the system side of the dry pipe valve.

Exception: Systems equipped with low air or nitrogen pressure alarms shall be inspected monthly.

9-4.4.1.3 The dry pipe valve shall be inspected weekly to ascertain that:

(a) The valve is free of physical damage.

(b) All trim valves are in their appropriate open or closed position.

(c) There is no leakage from the intermediate chamber.

9-4.4.1.4 The interior of the dry pipe valve shall be inspected annually when the trip test is conducted.

9-4.4.1.5 Strainers, filters, and restricted orifices shall be inspected internally every five years unless tests indicate a more stringent frequency is required.

9-4.4.2 Testing.

9-4.4.2.1* Priming water level shall be tested quarterly.

9-4.4.2.2* Each dry pipe valve shall be tested annually during warm weather.

Exception: Dry pipe valves protecting freezers shall be trip tested in a manner that will not introduce moisture into the piping in the freezers.

9-4.4.2.2.1* Every third year and whenever the system is altered the dry pipe valve shall be trip tested with the control valve wide open and the quick opening device, if installed, in service.

9-4.4.2.2.2* In years when full flow testing in accordance with 9-4.2.2.2.1 is not required, each dry pipe valve shall be trip tested with the control valve partially open.

9-4.4.2.3 Grease or other sealing materials shall not be applied to the seating surfaces of dry pipe valves.

9-4.4.2.4* Quick opening devices, if installed, shall be tested semiannually.

9-4.4.2.5 A tag or card showing the date on which the dry pipe valve was last tripped and showing the name of the person and organization conducting the test shall be attached to the valve. Separate records of initial air and water pressure, tripping air pressure, and dry pipe valve operating condition shall be maintained on the premises for comparison with previous test results. Records of tripping time shall also be maintained for full flow trip tests.

9-4.4.2.6 Low air pressure alarms, if provided, shall be tested quarterly in accordance with the manufacturer's instructions.

9-4.4.2.7 Automatic air pressure maintenance devices, if provided, shall be tested yearly at the time of the annual dry pipe valve trip test, in accordance with the manufacturer's instructions.

9-4.4.3 Maintenance.

9-4.4.3.1* Leaks resulting in pressure losses greater than 10 psi (0.7 bar) per week shall be located and repaired.

9-4.4.3.2 During the annual trip test, the interior of the dry pipe valve shall be thoroughly cleaned and parts replaced or repaired as necessary.

9-4.4.3.3* Low points in dry pipe sprinkler systems shall be drained after each operation and before the onset of freezing weather conditions.

9-5 Pressure Regulating and Relief Valves.

9-5.1 Sprinkler Pressure Regulating Control Valves.

9-5.1.1 All valves shall be inspected monthly. The inspection shall verify that the valves are:

(a) In the open position.

(b) Not leaking.

(c) Maintaining downstream pressures per the design criteria.

(d) In good condition, with handwheels installed and not broken.

9-5.1.2* A flow test shall be conducted on each valve annually.

9-5.2 Hose Connection Pressure Regulating Valves.

9-5.2.1 All valves shall be inspected weekly. The inspection shall verify that:

(a) The handwheel is not broken or missing.

(b) The outlet hose threads are not damaged.

(c) There are no leaks.

(d) The reducer and the cap are not missing.

9-5.2.2* A flow test shall be conducted on each valve at five-year intervals in accordance with the manufacturer's instructions.

9-5.3 Hose Rack Assembly Pressure Regulating Valves.

9-5.3.1 All valves shall be inspected monthly. The inspection shall verify that:

(a) The handwheel is not missing or broken.

(b) There are no leaks.

9-5.3.2 A flow test shall be conducted on each valve at five-year intervals in accordance with the manufacturer's instructions.

9-5.4 Fire Pump Pressure Relief Valves.

9-5.4.1 All circulation relief valves shall be inspected weekly.

9-5.4.1.1 The inspection shall verify that sufficient water flows through the valve when the fire pump is operating at shutoff pressure (churn) to prevent pump overheating.

9-5.4.1.2 During the annual fire pump test, it shall be verified that this valve closes in accordance with the manufacturer's specifications.

9-5.4.2 All pressure relief valves shall be inspected weekly.

9-5.4.2.1 The inspection shall verify that the pressure down stream of the relief valve fittings in the fire pump discharge piping does not exceed the pressure for which the system components are rated.

9-5.4.2.2 During the annual fire pump flow test, it shall be verified that this valve is correctly adjusted and set to relieve at the appropriate pressure and closes below that pressure setting.

9-5.5 Maintenance. All damaged or missing components noted during the inspections mentioned above shall be repaired or replaced in accordance with the manufacturer's instructions.

9-6 Backflow Prevention Assemblies.

9-6.1 Double Check Assembly (DCA) and Double Check Detector Assembly (DCDA).

9-6.1.1 Double check assembly (DCA) and double check detector assembly valve (DCDA) shall be inspected weekly to ensure that the OS&Y isolation valves are in the normal open position.

9-6.1.2* Reduced pressure (RP) and reduced pressure detector assemblies (RPDA) shall be inspected weekly to ensure the differential sensing valve relief port is not continuously discharging and the OS&Y isolation valves are in the normal open position. After any testing or repair, an inspection by the owner shall be made to ensure that the system is in service and all isolation valves are in the normal open position and properly locked or electrically supervised.

Exception: Valves secured with locks or electrically supervised in accordance with applicable NFPA standards shall be inspected monthly.

9-6.2* Testing. All backflow prevention assemblies shall be tested annually in accordance with the procedure and policies of the authority having jurisdiction.

9-6.2.1* Backflow Devices. All backflow devices installed in fire protection water supply shall be tested annually at the designed flow rate of the sprinkler system, including hose stream demands if appropriate, and the friction loss across the device measured and compared to the device manufacturer's specifications.

Exception: Where connections of a size sufficient to conduct a full flow test are not available, tests shall be conducted at the maximum flow rate possible.

9-6.3 Maintenance.

9-6.3.1 Maintenance of all backflow prevention assemblies shall be conducted by a trained individual following the manufacturer's instructions in accordance with the procedure and policies of the authority having jurisdiction.

9-6.3.2 Rubber parts shall be replaced in accordance with the frequency required by the authority having jurisdiction, following the manufacturer's instructions.

9-7 Fire Department Connections.

9-7.1 Fire department connections shall be inspected monthly. The inspection shall verify that:

(a) The fire department connections are visible and accessible.

(b) Couplings or swivels are not damaged and rotate smoothly.

(c) Plugs or caps are in place and not damaged.

(d) Gaskets are in place and in good condition.

(e) Identification signs are in place.

(f) The check valve is not leaking.

(g) The automatic drain valve is in place and operating properly.

9-7.2 If fire department connection plugs or caps are not in place, the interior of the connection shall be inspected for obstructions and it shall be verified that the valve clapper is operational over its full range.

9-7.3 Components shall be repaired or replaced as necessary, in accordance with the manufacturer's instructions. Any obstructions that are present shall be removed.

Chapter 10 Impairments

10-1 General. This chapter provides the minimum requirements for a water-based fire protection system impairment program. Adequate measures shall be taken during the impairment to ensure that increased risks are minimized and the duration of the impairment is limited.

10-2 Impairment Coordinator. A representative of the building owner, manager, or tenant shall be assigned to coordinate all impairments and restoration of protection.

10-3 Tag Impairment System.

10-3.1* A tag shall be used to indicate that a system, or part thereof, has been removed from service.

10-3.2* The tag shall be posted at each fire department connection and system control valve indicating which system, or part thereof, has been removed from service. The authority having jurisdiction shall specify where the tag is to be placed.

10-4 Equipment Involved. The equipment impaired is the water-based fire protection system, or part thereof, that is removed from service. This shall include, but is not limited to, any of the following:

(a) Sprinkler systems

(b) Standpipe systems

(c) Fire hose systems

(d) Underground fire service mains

(e) Fire pumps

(f) Water storage tanks

(g) Water spray fixed systems

(h) Foam-water systems

(i) Fire service control valves.

10-5* Preplanned Impairment Programs. All preplanned impairments shall be authorized by the impairment coordinator. Before authorization is given, the impairment coordinator shall be responsible for verifying that the following has been accomplished:

(a) The extent and expected duration of the impairment has been determined.

(b) The areas or buildings involved have been inspected and the increased risks determined.

(c) Recommendations have been submitted to management or building owner/manager.

(d) The fire department has been notified.

(e) The insurance carrier, the alarm company, building owner/manager, and other authorities having jurisdiction have been notified.

(f) The supervisors in the areas to be affected have been notified.

(g) A tag impairment system has been implemented (*see Section 10-3*).

(h) All necessary tools and materials have been assembled on the impairment site.

10-6 Emergency Impairments. Emergency impairments include but are not limited to system leakage, interruption of water supply, frozen or ruptured piping, and equipment failure. When this occurs, appropriate emergency action shall be taken to minimize potential injury and damage. The coordinator shall implement the steps outlined in Section 10-5.

10-7 Restoring Systems to Service. When all impaired equipment is restored to normal working order, the impairment coordinator shall verify that the following has been accomplished:

(a) Any necessary inspections and tests have been conducted to verify that affected systems are operational. The appropriate chapter of this standard shall be referenced to provide guidance on the type of inspection and test required.

(b) Supervisors have been advised that protection is restored.

(c) The fire department has been advised that protection is restored.

(d) The building owner/manager, insurance carrier, alarm company, and other authorities having jurisdiction have been advised that protection is restored.

(e) The impairment tag has been removed.

Chapter 11 Referenced Publications

11-1 The following documents or portions thereof are referenced within this standard and shall be 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.

11-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1991 edition

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 1990 edition

NFPA 16, *Standard on the Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems*, 1991 edition

NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*, 1990 edition

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 1987 edition

NFPA 72E, *Standard on Automatic Fire Detectors*, 1990 edition

NFPA 110, *Standard for Emergency and Standby Power Systems*, 1988 edition

NFPA 307, *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves*, 1990 edition

NFPA 409, *Standard on Aircraft Hangars*, 1990 edition

NFPA 1962, *Standard for the Care, Use, and Maintenance of Fire Hose Including Couplings and Nozzles*, 1988 edition

11-1.2 Other Publications.

11-1.2.1 AWWA Publication. American Water Works Association, 6666 W. Quincy Ave., Denver, CO 80235.

AWWA D100-1986, *Standard for Welded Steel Tanks for Water Storage*

Appendix A

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

A-1-2 History has shown that the performance reliability of a water-based fire protection system under fire related conditions increases when comprehensive inspection, testing, and maintenance procedures are enforced. Diligence during an inspection is important. Some items in the standard may not be practical or possible depending on existing conditions. The inspector should use good judgment in the practice of making inspections.

A-1-2.1 An entire program of quality control includes but is not limited to maintenance of equipment, inspection frequencies, testing of equipment, on-site fire brigades, loss control provisions, and personnel training. The latter can be an alternative acceptable even if specific frequencies are different from those specified in this standard.

A-1-3.9 Experience has shown that closed valves are the primary cause of failures of water-based fire protection systems in protected occupancies.

A-1-4.1 Inspection, testing, and maintenance may be contracted with an inspection, testing, and maintenance service.

A-1-4.4 Fire protection systems should not be removed from service when the building is not in use; however, when a system that has been out of service for a prolonged period (such as in the case of idle or vacant properties) is returned to service, it is recommended that a responsible and experienced contractor be retained to perform all inspections and tests.

A-1-8 Computer programs that file inspection and test results should allow the means of comparing current results with previous ones and indicate needs for corrective maintenance or further testing.

Acceptance test records should be retained for the life of the system or its special components. Subsequent test records should be retained for a period of at least one year beyond the next test. The comparison will indicate deterioration of system performance or condition and indicate the need for further testing or maintenance.

A-1-9.1 Substandard conditions, such as a closed valve, subnormal water pressure, loss of building heat or power, or obstruction of sprinklers, nozzles, detectors, or hose stations, can delay or prevent system actuation and impede manual fire fighting operations.

A-1-12.4 Most places using or storing hazardous materials have stations set up for employees where material safety data sheets (MSDS) are stored. The inspector should be familiar with the types of materials present and the appropriate actions to take in an emergency.

A-2-2.1.1 The conditions listed in this section can have a detrimental effect on the performance of sprinklers by affecting water distribution patterns, insulating thermal elements, delaying operation, or otherwise rendering the sprinkler inoperable or ineffectual.

A-2-2.1.1 Exception Examples include some floor/ceiling or roof/ceiling assemblies, areas under theater stages, nonremovable suspended ceilings, pipe chases, and other unaccessible areas.

A-2-2.2 The conditions listed in this section can have a detrimental effect on the performance and life of pipe by affecting corrosion rates or pipe integrity or otherwise rendering the pipe ineffectual.

A-2-2.2 Exception Examples include some areas under theater stages, nonremovable suspended ceilings, pipe chases, and other unaccessible areas.

A-2-2.3 The conditions listed in this section can have a detrimental effect on the performance of hangers and braces by allowing for failures should the components become loose.

A-2-2.3 Exception Examples include some floor/ceiling or roof/ceiling assemblies, areas under theater stages, nonremovable suspended ceilings, pipe chases, and other unaccessible areas.

A-2-2.4.1 Due to the high probability of a buildup of excess pressure, gridded wet pipe systems should be provided with a relief valve, not less than ¼ in. (6.3 mm) in size, as required by NFPA 13.

A-2-2.7 The hydraulic nameplate should be secured to the riser with durable wire, chain, or equivalent.

This system as shown on .....company
print no. .....dated.....
for.....
at ..... contract no.....
is designed to discharge at a rate of .....gpm
(L/min) per sq ft of floor area over a maximum
area of ..... sq ft (m^2) when supplied
with water at a rate of ..... gpm (L/min)
at ..... psi (bars) at the base of the riser.
Hose stream allowance of.....
gpm (L/min) is included in the above.

Figure A-2-2.7 Sample hydraulic nameplate.

A-2-3.1.1 Exception No. 3 Due to solder migration caused by the high temperatures that these devices are exposed to, it is important to test them every five years. Because of this phenomenon, operating temperature can vary over a wide range of values.

A-2-3.2 The normal life expectancy of a gauge is between 10 and 15 years. A gauge is permitted to have reading that is in error of ± 3 percent of the maximum gauge (full scale) reading. For example: A gauge having 200 psi maximum radius installed on a system with 60 psi normal pressure is acceptable if the gauge reads between 54 and 66 psi.

A-2-3.3 Testing the waterflow alarm on wet pipe systems should be completed by opening the inspector's test connection. This simulates activation of a sprinkler. When freezing weather conditions or other circumstances prohibit using the inspector's test connection, the by-pass test connection may be used.

A-2-3.3.1 Opening the inspector's test connection simulates activation of a sprinkler.

A-2-3.3.2 Opening the inspector's test connection may cause the system to trip accidentally.

A-2-3.4 Listed CPVC sprinkler pipe and fittings should be protected from freezing with glycerin only. The use of diethylene, ethylene, or propylene glycols is specifically prohibited. When inspecting antifreeze systems employing listed CPVC piping, verify that the solution is glycerin based.

A-2-4.1.1 Old-style sprinklers may be used to replace existing old-style sprinklers. Old-style sprinklers should not be used to replace standard sprinklers without a complete engineering review of the system. The old-style sprinkler is the type manufactured before 1953. It discharges approximately 40 percent of the water upward to the ceiling, and it can be installed in either the upright or pendent position.

A-2-4.1.6 Other types of wrenches may damage the sprinklers.

A-2-4.1.8 Corrosion-resistant or specially coated sprinklers are installed in locations where chemicals, moisture, or other corrosive vapors exist.

A-2-4.2 Conversion of dry pipe systems to wet will cause corrosion and accumulation of foreign matter in the pipe system and loss of alarm service.

A-2-4.3 For effective control and extinguishment of fire, automatic sprinklers must receive an unobstructed flow of water. Although the overall performance record of automatic sprinklers has been very satisfactory, there have been numerous instances of impaired efficiency because sprinkler piping or sprinklers were plugged with pipe scale, mud, stones, or other foreign material. If the first sprinklers to open in a fire are plugged, the fire in that area will not be extinguished or controlled by prewetting of adjacent combustibles. In such a situation, the fire may grow to uncontrollable size, resulting in greater fire damage and excessive sprinkler operation and even threatening structural integrity of the building, depending on the number of plugged sprinklers and fire severity.

Keeping the inside of sprinkler system piping free of scale, silt, or other obstructing material is an integral part of an effective loss prevention program.

Obstruction Sources

Pipe Scale

Loss studies have shown that dry pipe sprinkler systems are involved in the majority of obstructed sprinkler fire losses. Pipe scale was found to be the most frequent obstructing material. Dry pipe systems that have been maintained wet or dry alternately over a period of years are particularly susceptible to the accumulation of scale. Also, in systems continuously dry, condensation of moisture in the air supply may result in the formation of a hard scale along the bottom of the piping. When sprinklers open, the scale is broken loose and carried along the pipe, plugging some of the sprinklers or forming obstructions at the fittings.

Careless Installation or Repair

Many obstructions are caused by careless workers during installation or repair of yard or public mains and sprinkler systems. Wood, paint brushes, buckets, gravel, sand, and gloves have been found as obstructions. In some instances, with welded sprinkler systems and systems with holes for quick connect fittings, the cutout discs or coupons have been left within the piping, obstructing flow to sprinklers.

Raw Water Sources

Materials may be sucked up from the bottoms of rivers, ponds, or open reservoirs by fire pumps with poorly arranged or inadequately screened intakes and forced into the system. Sometimes floods damage intakes. Obstructions include fine compacted materials such as rust, mud, and sand. Coarse materials such as stones, cinders, cast-iron tubercles, chips of wood, and sticks are also common.

Biological Growth

Biological growth has been known to cause obstructions in sprinkler piping. The Asiatic clam has been found in fire protection systems supplied by raw river or lake water. With an available food supply and sunlight, these clams grow to about 3/8 to 7/16 in. (9 to 11 mm) across the shell in one year and up to 2 1/8 in. (54 mm) and larger by the sixth year. However, once in fire mains and sprinkler piping, the growth rate is much slower. The clams get into the fire protection systems in the larval stage or as small clams. They then attached themselves to the pipe and feed on bacteria or algae that may pass by.

Originally brought to Washington from Asia in the 1930s, the clams have spread throughout at least 33 states and may possibly be present in all states. River areas reported to be highly infested include the Ohio River, Tennessee River Valley, Savannah River (S. Carolina), Altamaha River (Georgia), Columbia River (Washington), and Delta-Mendota Canal (California).

Sprinkler Calcium Carbonate Deposits

Natural fresh waters contain dissolved calcium and magnesium salts in varying concentrations, depending on sources and location of the water. If the concentration of these salts is high, the water is called hard. A thin film composed largely of calcium carbonate, $CaCO_3$, affords some protection against corrosion when hard water flows through the pipes. However, hardness alone is not the only factor to determine whether a film forms. Ability of $CaCO_3$ to precipitate on the metal pipe surface also depends on the total acidity or alkalinity, the concentration of dissolved solids in the water, and the pH. In soft waters, no such film can form.

In automatic sprinkler systems, the calcium carbonate scale formation tends to occur on the more noble metal in the electrochemical series, copper, just as corrosion will affect the less noble metal, iron. Consequently, scale formation naturally forms on sprinklers, often plugging the orifice. The piping may be relatively clear. This type of sprinkler obstruction cannot be detected or corrected by normal flushing procedures. It can only be found by removal and inspection of sprinklers in suspected areas.

Most public water utilities in very hard water areas soften their water to reduce consumer complaints of scale buildup in water heaters. Thus, the most likely locations for deposits in sprinkler systems are where sprinklers are not connected to public water but supplied without treatment, directly from wells or surface water in very hard water areas. These areas are generally the Mississippi basin west of the Mississippi and north of the Ohio, the rivers of Texas and the Colorado basin, and other white areas in Figure A-2-3.3(a). (Great Lakes water is only moderately hard.)

Within individual plants, sprinklers most likely to have deposits are in the following locations:

1. In wet systems only.
2. In high temperature areas, except where water has unusually high pH. [See Figure A-2-3.3(b).] High temperature areas include around dryers, ovens, near skylights, or at roof peaks.
3. In old sprinkler systems that are frequently drained and refilled.
4. In pendent sprinklers that are away from air pockets and near convection currents.

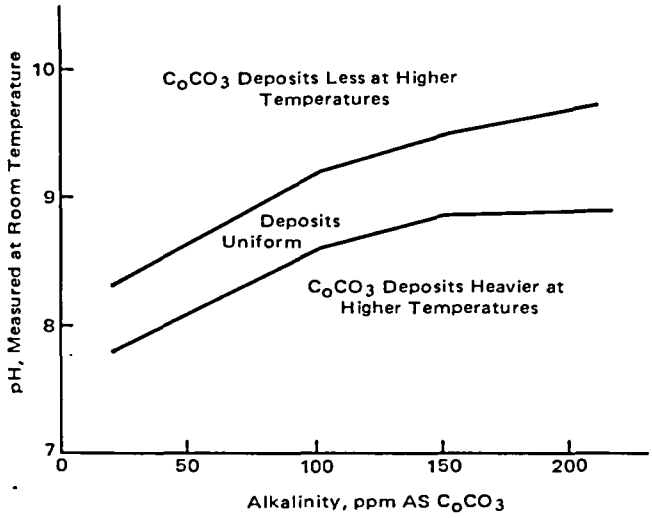


Figure A-2-4.3 Scale deposition, as a function of the alkalinity-pH ratio.

A-2-4.3.1 Investigation Procedure. Should unsatisfactory conditions be observed as outlined in 2-4.3, investigations should be made to determine the extent and severity of obstructing material. From the fire protection system plan, determine water supply sources, age of underground mains and sprinkler systems, types of systems, and general piping arrangement. Consider the possible sources of obstruction material.

Examine the fire pump suction supply and screening arrangements. If needed, have the suction cleaned before using the pump in tests and flushing operations. Gravity tanks should be inspected internally, except steel tanks that have been recently cleaned and painted. If possible, have the tank drained and determine whether loose scale is on the shell or if sludge or other obstructions are on the tank bottom. Cleaning and repainting may be in order, particularly if it has not been done within the past five years.

Investigate yard mains first, then sprinkler systems. WHEN FIRE PROTECTION CONTROL VALVES ARE CLOSED DURING INVESTIGATION PROCEDURES, FIRE PROTECTION IMPAIRMENT PRECAUTIONS OUTLINED IN CHAPTER 10 SHOULD BE FOLLOWED.

Large quantities of water are required for investigation and for flushing. It is important to plan in advance the safest means of disposal. Cover stock and machinery susceptible to water damage, and keep equipment on hand for mopping up any accidental discharge of water.

Investigating Yard Mains

Flow water through yard hydrants, preferably near the extremes of selected mains, to determine whether mains contain obstructive material. Preferably connect two lengths of 2½-in. (640-mm) hose to the hydrant. Attach burlap bags to free ends of the hose from which the nozzles have been removed to collect any material flushed out, and flow water long enough to determine condition of the main being investigated. If there are several sources of water supply, investigate each independently, avoiding any unnecessary interruptions to sprinkler protection. In extensive yard layouts, repeat the tests at several locations, if necessary, to determine general conditions.

If obstructive material is found, all mains should be thoroughly flushed before investigating sprinkler systems. (*See A-2-4.3.2, Flushing Procedure.*)

Investigating Sprinkler Systems

Investigate dry systems first. Tests on several carefully selected, representative systems usually are sufficient to indicate general conditions throughout the plant. If, however, preliminary investigations indicate obstructing material, this would justify investigating all systems (both wet and dry) before outlining needed flushing operations. Generally, the system can be considered reasonably free of obstructing material if (a) less than ½ cup of scale is washed from the cross mains, (b) scale fragments are not large enough to plug a sprinkler orifice, and (c) a full unobstructed flow is obtained from each branch line checked. When other types of foreign material are found, judgment is needed when considering the system unobstructed. Obstruction potential is based on the physical characteristics and source of the foreign material.

In selecting specific systems or branch lines for investigating, consider:

1. Lines found obstructed during a fire or during maintenance work.

2. Systems adjacent to points of recent repair to yard mains, particularly if hydrant flow shows material in the main.

Tests should include flows through 2½-in. (64-mm) fire hose directly from cross mains [Figures A-2-4.3.1(a) and (b)] and flows through 1½-in. (38-mm) hose from representative branch lines. Two or three branch lines per system is a representative number of branch lines when investigating for scale accumulation. Should significant scale be found, investigation of additional branch lines is warranted. When investigating for foreign material (other than scale), the number of branch lines needed for representative sampling is dependent on the source and characteristic of the foreign material.

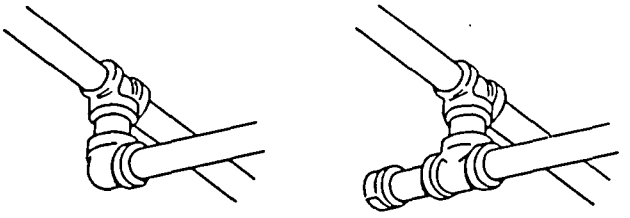


Figure A-2-4.3.1(a) Replacement of elbow at end of cross main with a flushing connection consisting of a 2-in. (50-mm) nipple and cap.

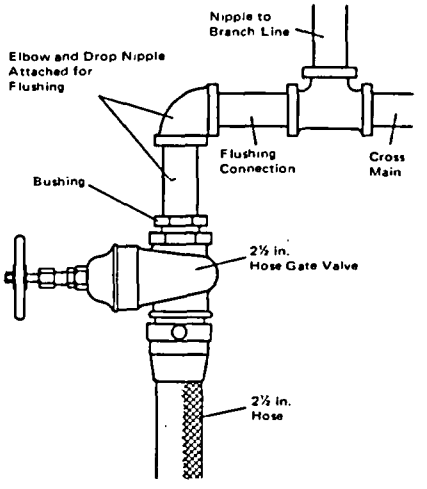


Figure A-2-4.3.1(b) Connection of 2½-in. (64-mm) hose gate valve with a 2-in. (50-mm) bushing and nipple and elbow to 2-in. (50-mm) cross main.

If provided, fire pumps should be operated for the large line flows, as maximum flow is desirable. Burlap bags should be used to collect dislodged material as is done in the investigation of yard mains. Each flow should be continued until the water clears. (All a minimum of 2 to 3 min. at full flow for sprinkler mains.) This should be sufficient to show the conditions of the piping interior.

Dry Pipe Systems

Flood dry pipe systems one or two days before obstruction investigations to soften pipe scale and deposits. Having selected the test points of a dry pipe system, close the main control valve and drain the system. Check the piping visually with a flashlight while it is being dismantled. Attach hose valves and 1½-in. (38-mm) hose to ends of lines to be tested, shut these valves, and have air pressure restored on the system and the control valve reopened. Open the hose valve on the end branch line, allowing the system to trip in simulation of normal action. Any obstructions should be cleared from the branch line before proceeding with further tests.

After flowing the small end line, shut its hose valve and test the feed or cross main by discharging water through a 2½-in. (64-mm) fire hose, collecting any foreign material in a burlap bag.

After the test, the dry pipe valve should be internally cleaned and reset. Its control valve should be locked open and a drain test made.

Wet Pipe Systems

Testing of wet systems is similar to that of dry systems except that the system must be drained after closing the control valve to permit installation of hose valves for the test. Slowly reopen the control valve and make a small hose flow as prescribed for the branch line, followed by the 2½-in. (64-mm) hose flow for the cross main.

In any case, if lines become plugged during the tests, piping must be dismantled and cleaned, the extent of plugging noted, and a clear flow obtained from the branch line before proceeding further.

Make similar tests on representative systems to indicate the general condition of the wet systems throughout the plant, keeping a detailed record of what is done.

Other Obstruction Investigation Methods

Other obstruction investigation methods, such as ultrasonic and X-ray examination, have been evaluated. Although these methods are successful at detecting obstructions, they tend to be time-consuming and require direct access to sprinkler piping. For most situations, they are presently no more economical or practical than the conventional flushing investigation method.

The sources of the obstructing material should be determined and steps taken to prevent further entrance of such material. This entails such work as inspection and cleaning of pump suction screening facilities or cleaning of private reservoirs. If recently laid public mains appear to be the source of the obstructing material, waterworks authorities should be requested to flush their system.

A-2-4.3.2 Flushing Procedures.

Yard Mains

Yard mains should be thoroughly flushed before flushing any interior piping. Flush yard piping through hydrants at dead ends of the system or through blow-off valves, allowing the water to run until clear. If the water is supplied from more than one direction or from a looped system, close divisional valves to produce a high velocity flow through each single line. A velocity of at least 10 ft/sec (3 m/sec) is necessary for scouring the pipe and for lifting foreign material to an aboveground flushing outlet. Use the flow specified in Table A-2-4.3.2 or the maximum flow available for the size of the yard main being flushed.

Connections from yard piping to sprinkler riser should be flushed. These are usually 6-in. (150-mm) mains. Although flow through a short, open-ended 2-in. (50-mm) drain may create sufficient velocity in a 6-in. (250-mm) main to move small obstructing material, the restricted waterway of the globe valve usually found on a sprinkler drain may not allow stones and other large objects to pass. If the presence of large size material is suspected, a larger outlet will be needed to pass such material and to create the flow necessary to move it. Fire department connections on sprinkler risers can be used as flushing outlets by removing the clappers. Yard mains can also be flushed through a temporary siamese fitting attached to the riser connection before the sprinkler system is installed. [Figure A-2-4.3.2(a).]

Sprinkler Piping

Two methods are commonly used for flushing sprinkler piping: (1) the hydraulic method, and (2) the hydropneumatic method.

The hydraulic method consists of flowing water progressively from the yard mains, sprinkler risers, feed mains, cross mains, and finally the branch lines in the same direction in which it would flow during a fire.

The hydropneumatic method uses special equipment and compressed air to blow a charge of about 30 gal (114 dm^3) of water from the ends of branch lines back into feed mains and down the riser, washing the foreign material out of an opening at the base of the riser.

The choice of method depends on conditions at the individual plant and the type of material installed. If examination indicates the presence of loose sand, mud, or moderate amounts of pipe scale, the piping can generally be satisfactorily flushed by the hydraulic method. Where the material is more difficult to remove and available water pressures are too low for effective scouring action, the hydropneumatic method is generally more satisfactory. The hydropneumatic method should not be used with listed CPVC sprinkler piping.

In some cases, where obstructive material is solidly packed or adheres tightly to the walls of the piping, the pipe will have to be dismantled and cleaned by rodding or other means.

Dry pipe systems should be flooded one or two days before flushing to soften pipe scale and deposits.

Successful flushing by either the hydraulic or hydropneumatic method is dependent on establishing sufficient velocity of flow in the pipes to remove silt, scale, and other obstructive material. With the hydraulic method, water should be moved through the pipe at least at the rate of flow indicated in Table A-2-4.3.2.

Table A-2-4.3.2

Size of pipe in.	(mm)	Flow gpm	(dm^3/min)	Size of pipe in.	(mm)	Flow gpm	(dm^3/min)
¾	(19)	10	(38)	3½	(89)	180	(681)
1	(25)	16	(61)	4	(100)	240	(909)
1¼	(32)	28	(106)	5	(125)	360	(1363)
1½	(38)	38	(144)	6	(150)	750	(2839)
2	(50)	60	(227)	8	(200)	1000	(3785)
2½	(64)	90	(341)	10	(250)	1500	(5678)
3	(76)	130	(492)	12	(300)	2000	(7571)

When flushing a branch line through the end pipe, sufficient water must be discharged to scour the largest pipe in the branch line. Lower rates of flow may reduce the efficiency of the flushing operation. To establish the recommended flow, remove small end piping and connect hose to a larger section, if necessary.

Where pipe conditions indicate internal or external corrosion, a section of the pipe affected should be thoroughly cleaned to determine if the walls of the pipe have seriously weakened. Hydrostatically test as outlined in NFPA 13, *Standard for the Installation of Sprinkler Systems.*

Pendent sprinklers should be removed and inspected until reasonably sure all are free of obstruction material.

Painting the ends of branch lines and cross mains is a convenient method for keeping a record of those pipes that have been flushed.

Hydraulic Method

After the yard mains have been thoroughly cleaned, flush risers, feed mains, cross mains, and finally the branch lines. In multistory buildings, systems should be flushed by starting at the lowest story and working up. Branch line flushing in any story may immediately follow the flushing of feed and cross mains in that story, allowing one story to be completed at a time. Following this sequence will prevent drawing obstructing material into the interior piping.

To flush risers, feed mains, and cross mains, attach 2½-in. (64-mm) hose gate valves to the extreme ends of these lines [Figure A-2-4.3.2(b)]. Such valves usually can be procured from the manifold of fire pumps or hose standpipes. As an alternative, an adapter with 2½-in. (64-mm) hose thread and standard pipe thread can be used with a regular gate valve. A length of fire hose without a nozzle should be attached to the flushing connection. To prevent kinking of the hose and to obtain maximum flow, an elbow should usually be installed between the end of the sprinkler pipe and the hose gate valve. Attach the valve and hose so that no excessive strain will be placed on the threaded pipe and fittings. Support hose lines properly.

Where feed and cross mains and risers contain pipe 4-, 5-, and 6-in. (100-, 125-, and 150-mm) in diameter, it may be necessary to use a Siamese with two hose connections to obtain sufficient flow to scour this larger pipe.

Flush branch lines after feed and cross mains have been thoroughly cleared. Equip the ends of several branch lines with gate valves, and flush individual lines of the group consecutively. This will eliminate the need for shutting off and draining the sprinkler system to change a single hose line. The hose should be of 1½-in. (38-mm) diameter and as short as practicable. Branch lines may be flushed in any order that will expedite the work.

Branch lines may also be flushed through pipe 1½-in. (38-mm) or larger extending through a convenient window. If pipe is used, 45-degree fittings should be provided at the ends of branch lines. When flushing branch lines, hammering the pipes is an effective method of moving obstructions.

Figure A-2-4.3.2(b) shows a typical gridded piping arrangement prior to flushing. The flushing procedure is as follows:

1. Disconnect all branch lines and cap all open ends.
2. Remove the cap from the east end of the south cross main, flush the main, and replace the cap.
3. Remove the cap from branch line 1, flush the line, and replace the cap.
4. Repeat Step 3 for the remaining branch lines.
5. Reconnect enough branch lines at the west end of the system so that the aggregate cross-sectional area of the branch lines approximately equals the area of the north cross main. For example, three 1¼-in. (32-mm) branch lines approximately equal a 2½-in. (64-mm) cross main. Remove the cap from the east end of the north cross main, flush the main, and replace the cap.
6. Disconnect and recap the branch lines. Repeat Step 5 but by reconnecting branch lines at the east end of the system and flushing the north cross main through its west end.
7. Reconnect all branch lines and recap the cross main. Verify that the sprinkler control valve is left in the open and locked position.

Hydropneumatic Method

The apparatus used for hydropneumatic flushing consists of a hydropneumatic machine, a source of water, a source of compressed air, 1-in. (25-mm) rubber hose for connecting to branch lines, and 2½-in. (64-mm) hose for connecting to cross mains.

The hydropneumatic machine [Figure A-2-4.3.2(c)] consists of a 30-gal (114-dm^3) water tank mounted over a 25-ft^3 (185-gal) (700-dm^3) compressed air tank. The compressed air tank is connected to the top of the water tank through a 2-in. (50-mm) lubricated plug cock. The bottom of the water tank is connected through hose to a suitable water supply. The compressed air tank is connected through suitable air hose to either the plant air system or a separate air compressor.

To flush the sprinkler piping, the water tank is filled with water, the pressure is raised to 100 psi (690 kPa) in the compressed air tank, and the plug cock between tanks is opened to put air pressure on the water. The water tank is connected by hose to the sprinkler pipe to be flushed. Then the lubricated plug cock on the discharge outlet at the bottom of the water tank is snapped open, permitting the water to be "blown" through the hose and sprinkler pipe by the compressed air. The water tank and air tank must be recharged after each blow.

Outlets for discharging water and obstructing material from the sprinkler system must be arranged. With the clappers of dry pipe valves and alarm check valves on their seats and cover plates removed, sheet metal fittings can be

used for connection to 2½-in. (64-mm) hose lines or for discharge into a drum. [Maximum capacity per blow is about 30 gal (114 dm³).] If the 2-in. (50-mm) riser drain is to be used, the drain valve should be removed and a direct hose connection made. For wet pipe systems with no alarm check valves, the riser must be taken apart just below the drain opening and a plate inserted to prevent foreign material from dropping to the base of the riser. Where dismantling of a section of the riser for this purpose is impractical, the hydropneumatic method should not be used.

Before starting a flushing job, each sprinkler system to be cleaned must be studied and a schematic plan prepared showing the order of the blows.

To determine that the piping is clear after it has been flushed, representative branch lines and cross mains should be investigated, using both visual examination and sample flushings.

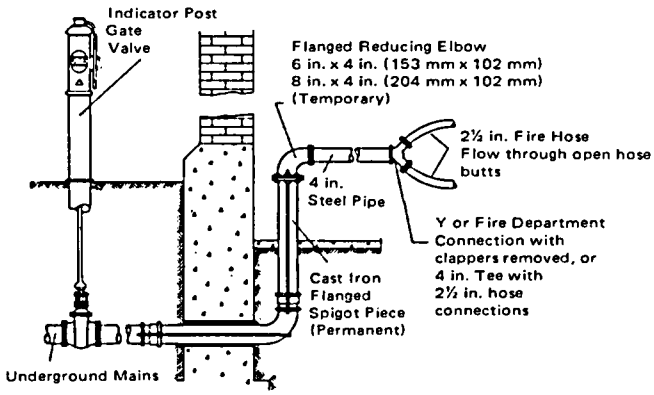


Figure A-2-4.3.2(a) Arrangement for flushing branches from underground mains to sprinkler risers.

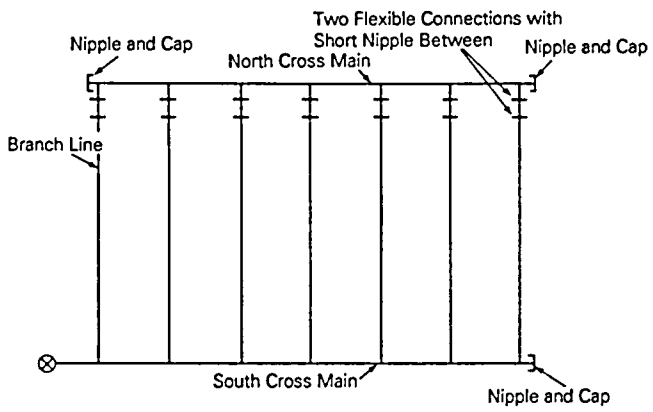
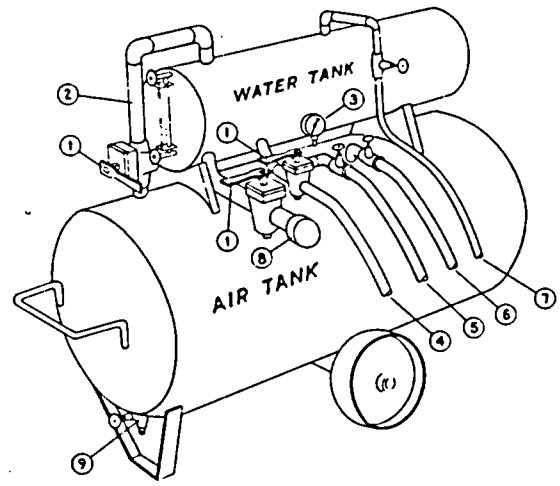


Figure A-2-4.3.2(b) Gridded sprinkler system piping.



1. Lubricated plug cocks.
2. Pipe connection between air and water tanks. This connection is open when flushing sprinkler system.
3. Air pressure gauge.
4. 1-in. (25-mm) rubber hose (air type). Used to flush sprinkler branch lines.
5. Hose connected to source of water. Used to fill water tank.
6. Hose connected to ample source of compressed air. Used to supply air tank.
7. Water tank overflow hose.
8. 2½-in. pipe connection. When flushing large interior piping, connect woven jacket fire hose here and close 1-in. (25-mm) plug cock hose connection (4) used for flushing sprinkler branch lines.
9. Air tank drain valve.

Figure A-2-4.3.2(c) Hydropneumatic machine.

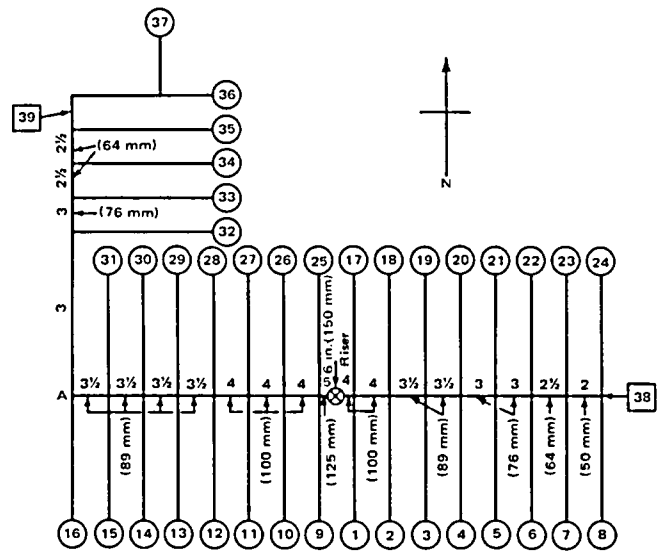


Figure A-2-4.3.2(d) Schematic diagram of sprinkler system showing sequence to be followed when hydropneumatic method is to be utilize.

1. Branch Lines

With the yard mains already flushed or known to be clear, the sprinkler branch lines should be flushed next. The order of cleaning individual branch lines must be carefully laid out if an effective job is to be done. In general, flush the branch lines starting with the branch closest to the riser and work toward the dead end of the cross main. [Figure A-2-4.3.2(d).] The order of flushing the branch lines is shown by the circled numerals. In this example, the southeast quadrant is flushed first, then the southwest, next the northeast, and, last, the northwest.

Air hose 1 in. (25 mm) in diameter is used to connect the machine with the end of the branch line being flushed. This hose air pressure should be allowed to drop to 85 psi (5.9 bars) (586 kPa) before the valve is closed. The resulting short slug of water will have less friction loss and a higher velocity and hence do a more effective cleaning job than if the full 30 gal (114 dm^3) of water is used. One blow is made for each branch line.

2. Large Piping

When flushing cross mains, completely fill the water tank and raise the pressure in the air receiver to 100 psi (690 kPa) (6.9 bars). Connect the machine to the end of the cross main to be flushed with no more than 50 ft (15.2 m) of 2½-in. (64-mm) hose. After opening the valve, allow air pressure in the machine to drop to zero. Two to six blows are necessary at each location, depending on the size and length of the main.

In Figure A-2-4.3.2(d), the numerals in squares indicate the location and order of the cross main blows. Since the last branch line blows were west of the riser, clean the cross main east of the riser first. Where large cross mains are to be cleaned, it is best, if practical, to make one blow at 38, one at 39, the next at 38, then at 39, alternating in this manner until the required number of blows has been made at each location.

When flushing cross mains and feed mains, arrange the work so that the water will pass through a minimum of right-angle bends. In Figure A-2-4.3.2(d), blows at 38 should be adequate to flush the cross mains back to the riser. Do not attempt to clean the cross main from A to the riser by backing out branch line 16 and connecting the hose to the open side of the tee. If this were done, a considerable portion of the blow would pass northward up the 3-in. (76-mm) line supplying branches 34 to 37, and the portion passing eastward to the riser could be ineffective. When the size, length, and condition of cross mains require blowing from a location corresponding to A, the connection should be made directly to the cross main corresponding to the 3½-in. (89-mm) pipe so that the entire flow would travel to the riser.

When flushing through a tee, always flush the run of tee after flushing the branch. Note the location of blows 35, 36, and 37 in Figure A-2-4.3.2(d).

Gridded systems may be flushed in a similar fashion. With branch lines disconnected and capped, begin by flushing the branch line closest to the riser [branch line 1 in Figure A-2-4.3.2(b)] working towards the most remote line. Next flushed in Figure A-2-4.3.2(b) is the south cross main by connecting the hose to the east end. Flushing the north cross main involves connecting the hose to one end while discharging to a safe location from the other end.

A-2-4.3.3 Obstruction Prevention Program

1. Dry Pipe and Preaction Systems — Scale.

(a) Dry pipe and preaction systems using noncoated ferrous piping should be thoroughly investigated for obstruction from corrosion after they have been in service for 15 years, 25 years, and every 5 years thereafter.

(b) Keep dry pipe systems with noncoated ferrous piping on air the year round, instead of alternately on air or water, to inhibit formation of rust and scale.

(c) Use piping that has been galvanized internally for new dry pipe and preaction sprinkler system installations. Fittings, couplings, hangers, and other appurtenances need not be galvanized. Copper or stainless steel piping is also acceptable.

2. Flushing Connections. Sprinkler systems installed in accordance with recent editions of NFPA 13 should have provisions for flushing each cross main. Similarly, branch lines on gridded systems should be capable of being readily "broken" at a simple union or flexible joint. Owners of systems installed without these provisions should be encouraged to provide them when replacement or repair work is being done.

3. Suction Supplies.

(a) Screen pump suction supplies and maintain screens. Equip connections from penstocks with strainers or grids, unless the penstock inlets themselves are so equipped. Pump suction screens of copper or brass wire tend to have less aquatic growth.

(b) Use extreme care when cleaning tanks and open reservoirs to prevent material from entering piping. Materials removed from the interior of gravity tank during cleaning must not be permitted to enter the discharge pipe.

(c) Small mill ponds may require periodic dredging where weeds and other aquatic growth are inherent.

4. Asian Clams. Effective screening of larvae and small size juvenile Asian clams from fire protection systems is very difficult. To date, no effective method of total control has been found. Such conditions may be difficult to achieve in fire protection systems.

5. Calcium Carbonate. For localities suspected of having hard water, sample sprinklers should be removed and inspected yearly. Paragraph A-2-4.3 outlines sprinkler locations prone to having deposits when hard water is a problem. Sprinklers found with deposits should be replaced and adjacent sprinklers checked.

6. Zebra Mussels. Several means of controlling the zebra mussel are being considered including molluscides, chlorines, ozone, shell strainers, manual removal, robotic cleaning, water jetting, line pigging, sonic pulses, high voltage electrical fields, and thermal backwashing. It is believed that these controls may only need to be applied during spawning periods when water temperatures are between 57°F and 61°F (14°C and 16°C) and veligers are

present. Several silicon-grease based coatings are also being investigated for use within piping systems.

While it appears that the use of molluscides may present the most effective means of controlling the mussel, these chemicals are costly. It is believed that chlorination is the best available short-term treatment, but there are problems associated with the use of chlorine, including strict Environmental Protection Agency regulations on the release of chlorine into lakes and streams. The use of nonselective poison such as chlorine in the amounts required to kill the mussels in large bodies of water could be devastating to entire ecosystems.

To provide an effective means of control against zebra mussels in fire protection systems, control measures must be applied at the water source, instead of within the piping system. Effective controls for growth of the zebra mussel within fire protection systems may include:

- Selecting a water source that is not subject to infestation. This may include well, potable, or pretreated water.
- Implementing a water treatment program that may include biocides, elevated pH, or both.
- Implementing a water treatment program to remove oxygen, which ensures control of biological growth within piping.
- Relying on a tight system approach to deny oxygen and nutrients that are necessary to support growth.

A-3-3.2.2 The intent of this paragraph is to ascertain whether the system will retain its integrity under fire conditions. Minimum leakage existing only under test pressure is not cause for repair.

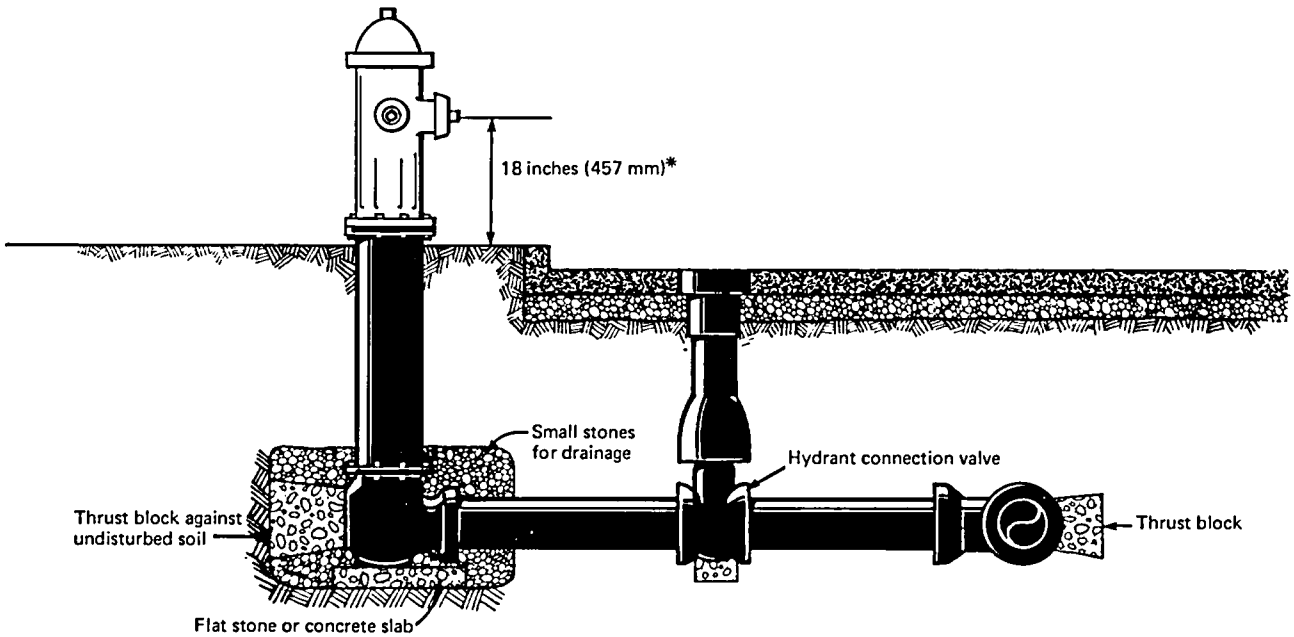


Figure A-4-2.2(a) Typical hydrant connection.

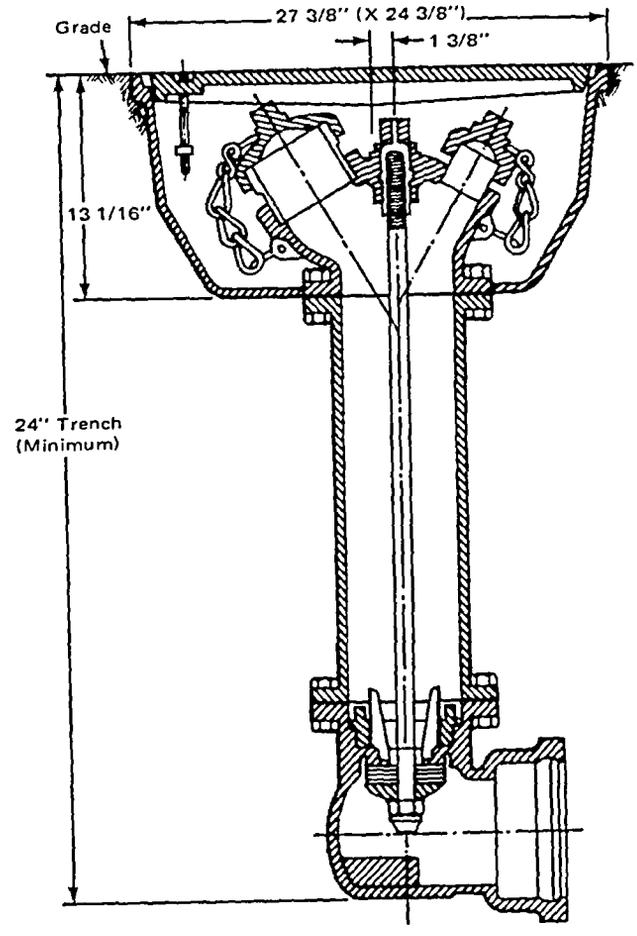


Figure A-4-2.2(b) Flush type hydrant.

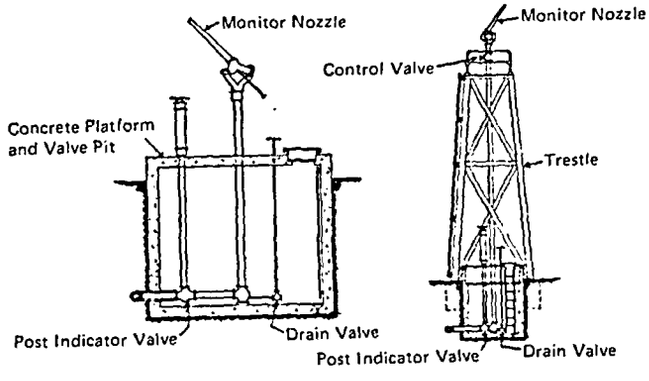


Figure A-4-2.3(a) Standard monitor nozzles. Gear control nozzles are also satisfactory.

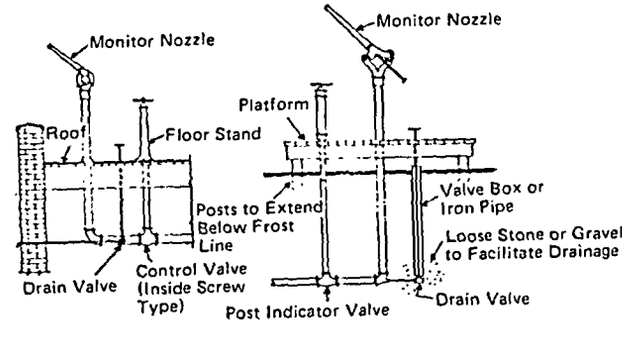


Figure A-4-2.3(b) Standard monitor nozzles, alternative arrangement.

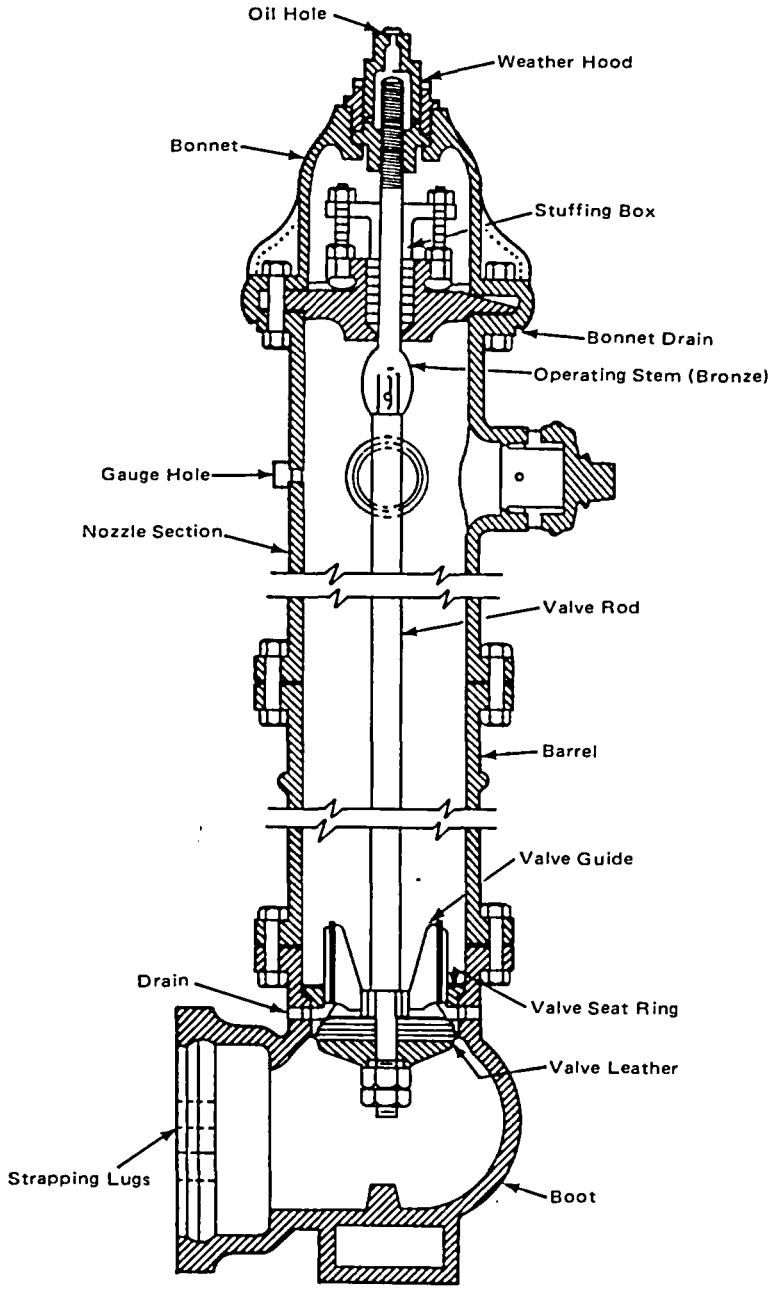
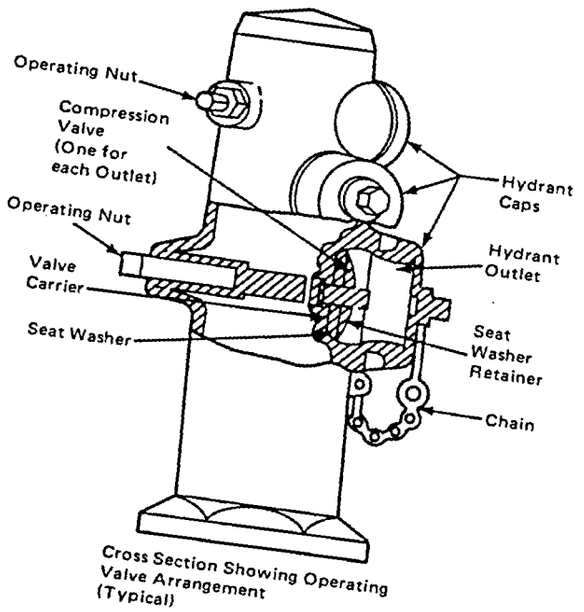
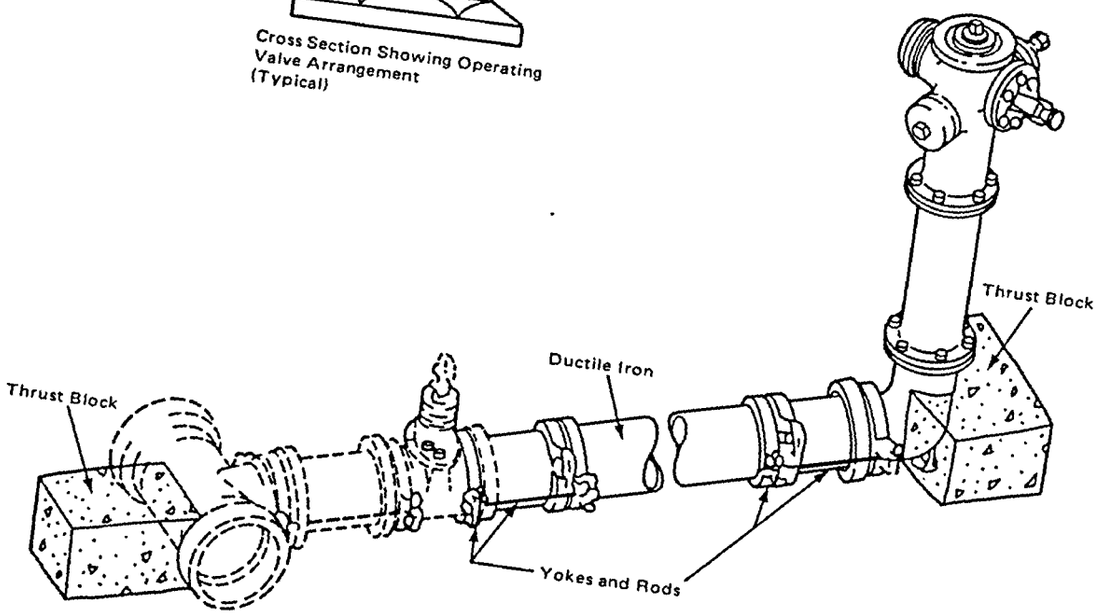


Figure A-4-2.4 Dry barrel hydrant.



Cross Section Showing Operating Valve Arrangement (Typical)



Note: Joint-Restraining Gaskets may be used in place of Yokes and Rods.

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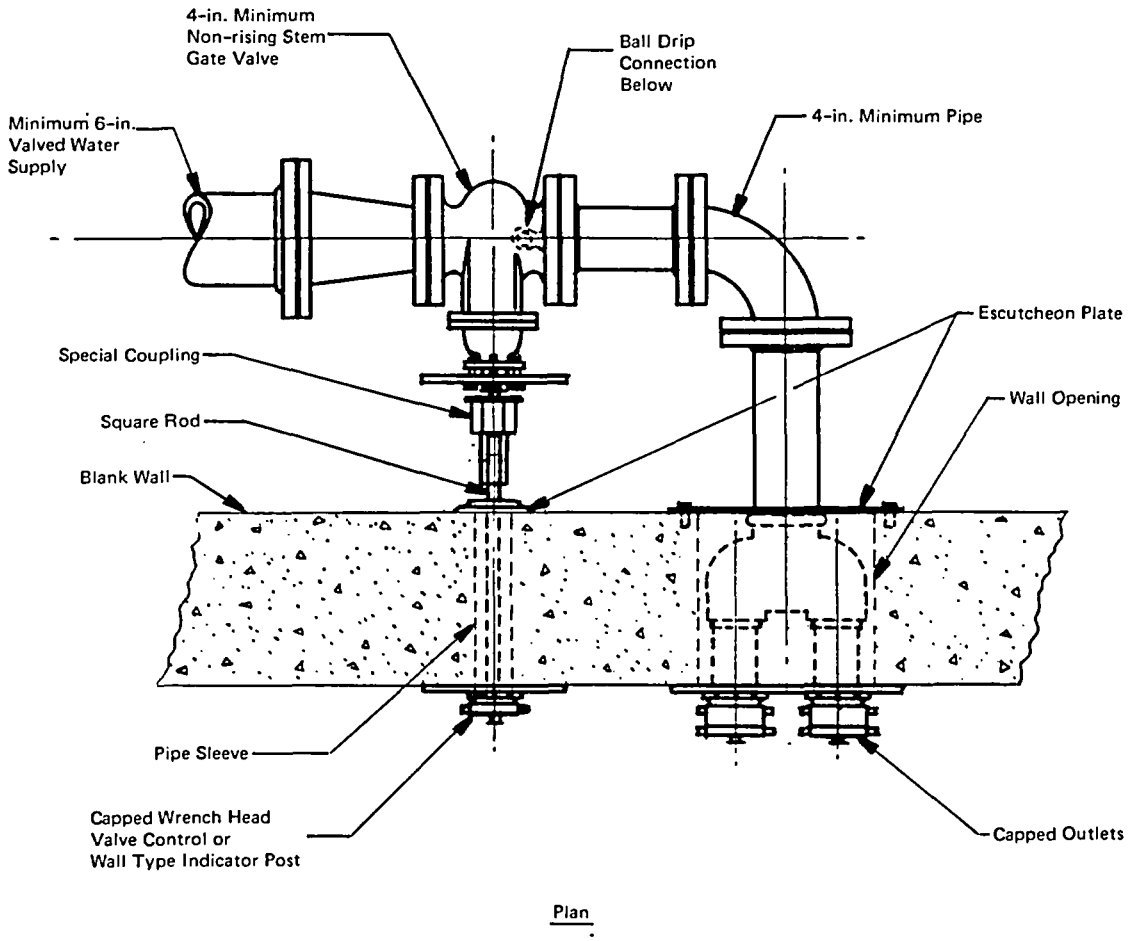
Figure A-4-2.5 Wet barrel hydrant.



Note: For SI Units: 1 in. = 25.4 mm.

Figure A-4-2.6 Wall hydrant.

A-4-2.8 House/Hydrant House. Desirable optional equipment to be included in hose house equipment is as follows:

1 - Fire axe with brackets
1 - Crow bar with brackets
2 - Hose and ladder straps
2 - Electrical battery hand lights

A-4-3.2.3 Any flow in excess of that through the main drain connection is considered to be significant.

A-4-4.1.1 Full flow tests of underground piping can be accomplished by methods including but not limited to flow through yard hydrants or fire department connections once the check valve has been removed.

A-4-5.3.2 The intent of this section is to maintain adequate space for use of hydrants during a fire emergency. The amount of space needed will depend on the configuration as well as the type and size of accessory equipment, such as hose, wrenches, and other devices that may be used.

A-5-1.2 Types of centrifugal fire pumps include single and multistage units of horizontal or vertical shaft design. Listed fire pumps have rated capacities of 25 gpm to 5000 gpm with net pressure range from approximately 40 psi to 400 psi (2.75 - 27.6 bars).

(a) *Horizontal Split Case.* This pump has double suction impeller with inboard and outboard bearing and is used with positive suction supply. A variation of this design may be mounted with the shaft in a vertical plane.

(b) *End Suction and Vertical In-Line.* This pump can have either a horizontal or vertical shaft with a single suction impeller, single bearing at the drive end.

(c) *Vertical Shaft Turbine Type.* This pump has multiple impellers and is suspended from the pump head by a column pipe that also serves as a support for the shaft and bearings. This pump is necessary where a suction lift is required, such as from an underground reservoir, well, river, or lake.

Figure A-4-2.7 Hydrant with monitor nozzle.

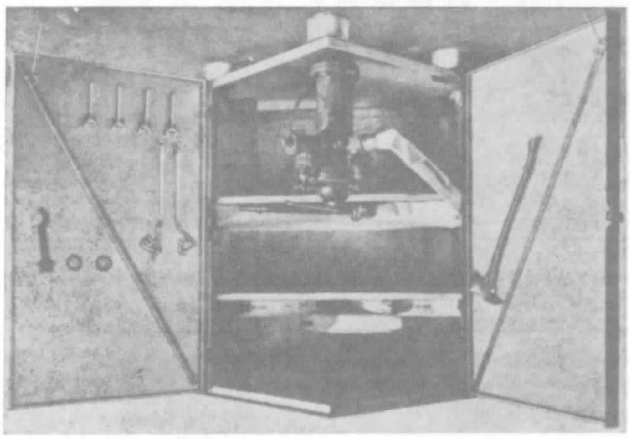


Figure A-4-2.8(a) House of five-sided design for installation over a private hydrant.

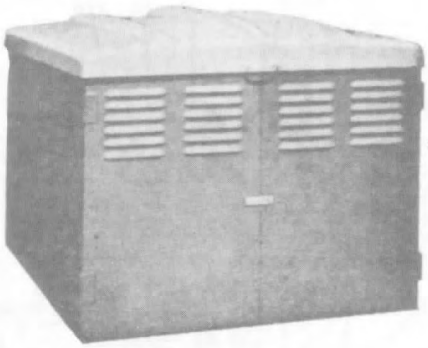


Figure A-4-2.8(b) Steel house of compact dimensions for installation over a private hydrant. House is shown closed. Top lifts up and doors on front side open for complete accessibility.

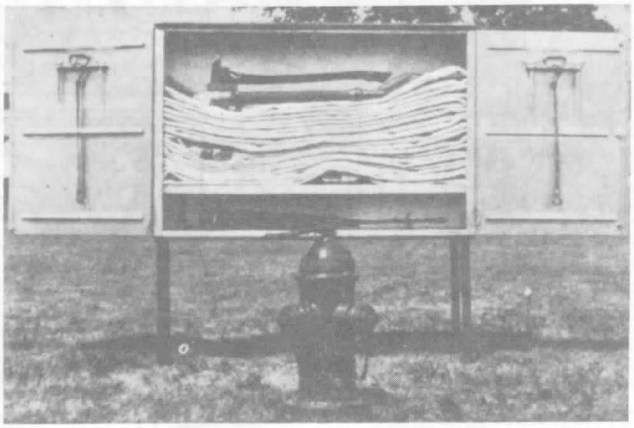
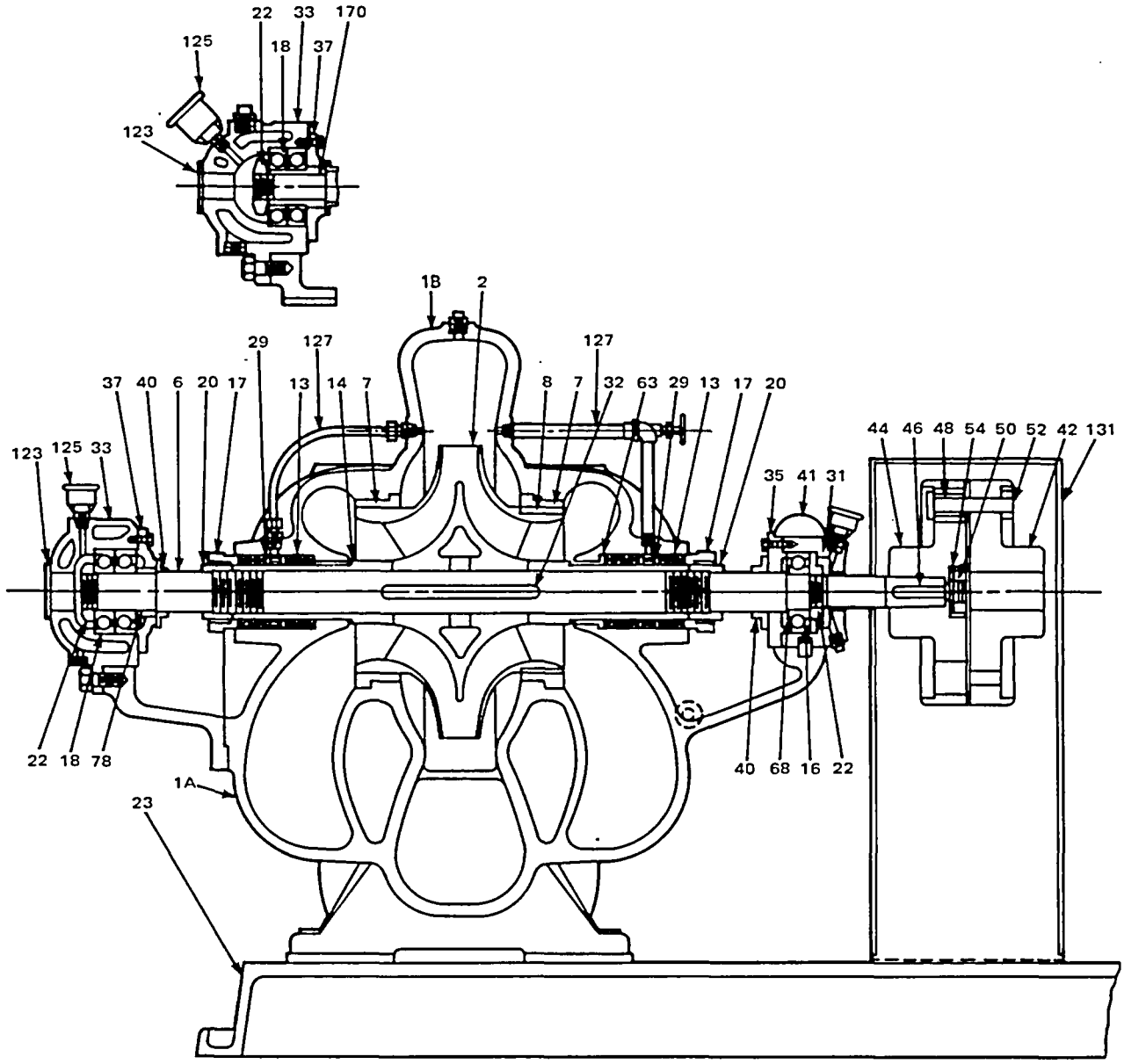


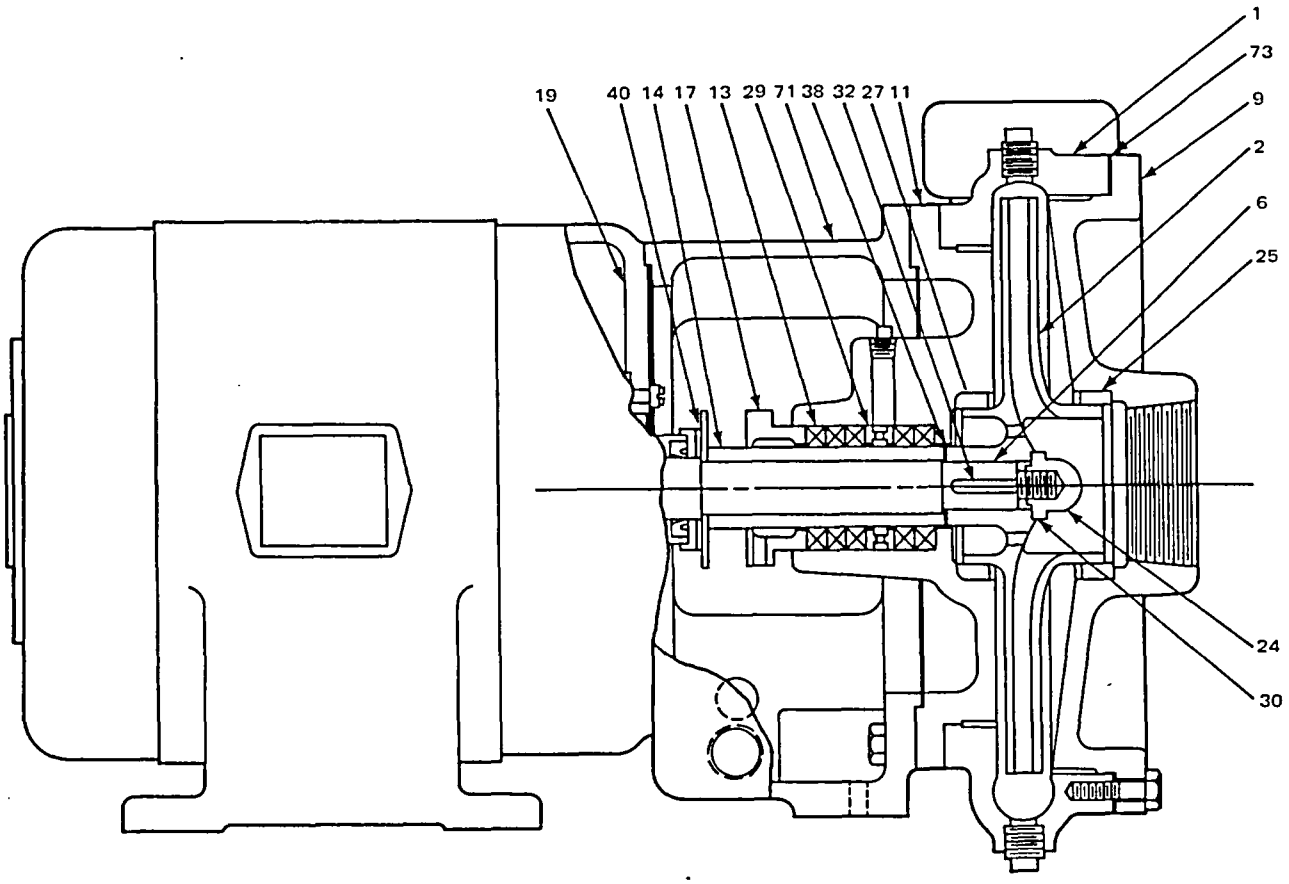
Figure A-4-2.8(c) This type of hose house can be installed on legs as illustrated or installed on a wall near, but not directly over, a private hydrant.



1A Casing, Lower Half
1B Casing, Upper Half
2 Impeller
6 Shaft, Pump
7 Ring, Casing
8 Ring, Impeller
13 Packing
14 Sleeve, Shaft
16 Bearing, Inboard
17 Gland
18 Bearing, Outboard
20 Nut, Shaft Sleeve
22 Locknut
23 Base Plate
29 Ring, Lantern
31 Housing, Bearing, Inboard
32 Key, Impeller
33 Housing, Bearing, Outboard
35 Cover, Bearing, Inboard
37 Cover, Bearing, Outboard
40 Deflector
41 Cap, Bearing, Inboard
42 Coupling Half, Driver
44 Coupling Half, Pump
46 Key, Coupling
48 Bushing, Coupling
50 Locknut, Coupling
52 Pin, Coupling
54 Washer, Coupling
63 Bushing, Stuffing Box
68 Collar, Shaft
78 Spacer, Bearing
123 Cover, Bearing End
125 Cup, Grease
127 Piping, Seal
131 Guard, Coupling
170 Adapter, Bearing

The numbers shown on this drawing do not necessarily represent standard part numbers in use by any manufacturer.

Figure A-5-1.2(a) (Part One) Impeller Between Bearings, Separately Coupled, Single Stage Axial (Horizontal) Split Case. (Courtesy of Hydraulic Institute Standards for Centrifugal, Rotary and Reciprocating Pumps, 14th Edition, Hydraulic Institute, Cleveland, OH.)

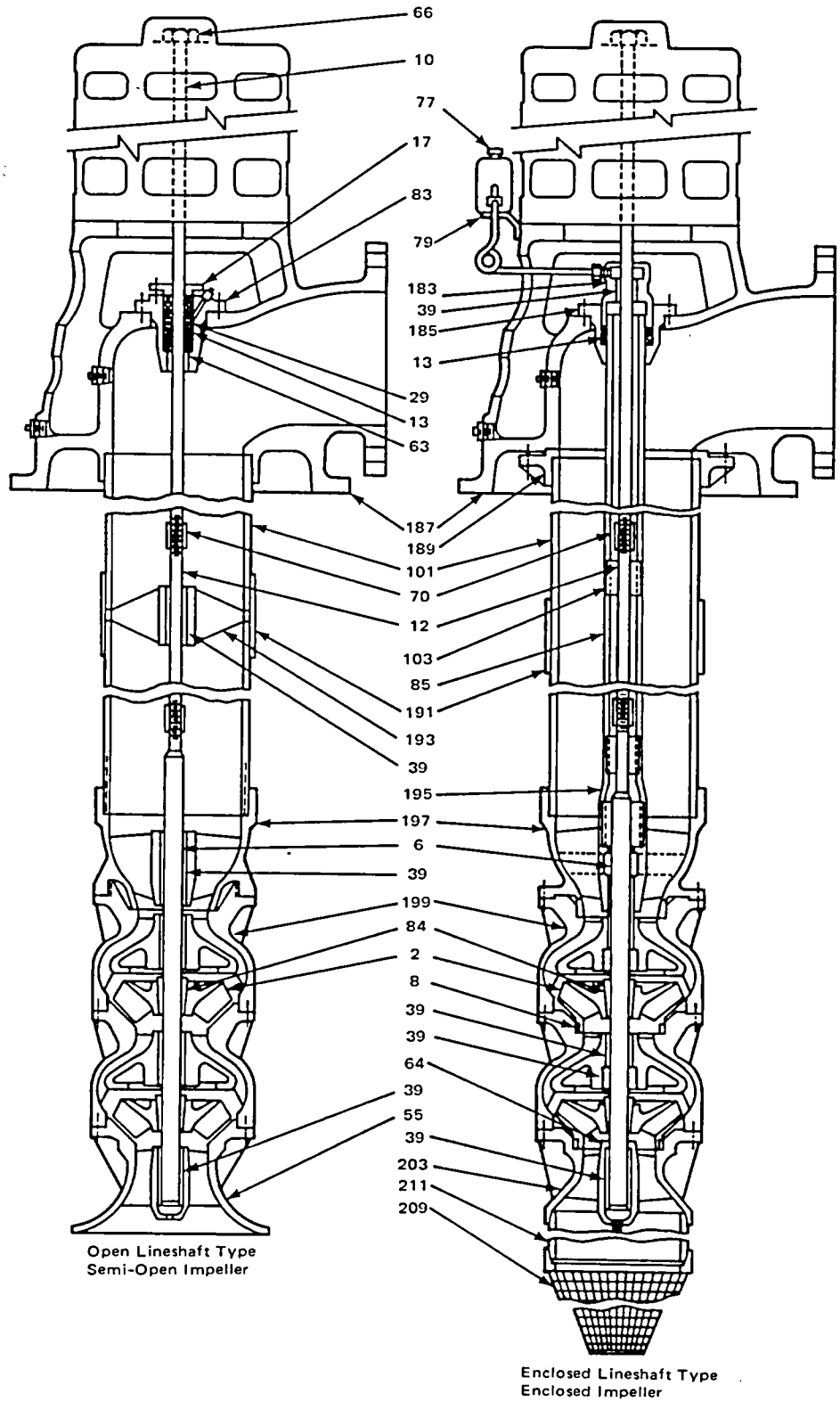


1 Casing
2 Impeller
6 Shaft
9 Cover, Suction
11 Cover, Stuffing Box
13 Packing
14 Sleeve, Shaft
17 Gland
19 Frame
24 Nut, Impeller
25 Ring, Suction Cover
27 Ring, Stuffing Box Cover
29 Ring, Lantern
30 Gasket, Impeller Nut
32 Key, Impeller
38 Gasket, Shaft Sleeve
40 Deflector
71 Adapter
73 Gasket

The numbers represented on this drawing do not necessarily represent standard part numbers in use by any manufacturer.

Figure A-5-1.2(b) Overhung Impeller, Close Coupled, Single Stage, End Suction. (Courtesy of Hydraulic Institute Standards for Centrifugal, Rotary and Reciprocating Pumps, 14th Edition, Hydraulic Institute, Cleveland, OH.)

2 Impeller
6 Shaft, Pump
8 Ring, Impeller
10 Shaft, Head
12 Shaft, Drive
13 Packing
17 Gland
29 Ring, Lantern
39 Bushing, Bearing
55 Bell, Suction
63 Bushing, Stuffing Box
64 Collar, Protecting
66 Nut, Shaft Adjusting
70 Coupling, Shaft
77 Lubricator
79 Bracket, Lubricator
83 Stuffing Box
84 Collet, Impeller Lock
85 Tube, Shaft Enclosing
101 Pipe, Column
103 Bearing, Line Shaft, Enclosed
183 Nut, Tubing
185 Plate, Tension, Tubing
187 Head, Surface Discharge
189 Flange, Top Column
191 Coupling, Column Pipe
193 Retainer Bearing, Open Lineshaft
195 Adapter, Tubing
197 Case, Discharge
199 Bowl, Intermediate
203 Case, Suction
209 Strainer
211 Pipe, Suction



The cross-sectional drawings illustrate the largest possible number of parts in their proper relationship and a few construction modifications but do not necessarily represent recommended design.

Figure A-5-1.2(c) Turbine Type, Vertical, Multi-Stage, Deep Well. (Courtesy of Hydraulic Institute Standards for Centrifugal, Rotary and Reciprocating Pumps, 14th Edition, Hydraulic Institute, Cleveland, OH.)

A-5-1.8 Controllers include air-, hydraulic-, or electric-operated units. These units may take power from the energy source for their operation, or the power may be obtained elsewhere. Controllers used with electric power sources may apply the source to the driver in one (across-the-line) or two (reduced voltage or current) steps. Controllers may be used with automatic and manual transfer switches to select the available electric power source when more than one is provided.

A-5-3.3.1 Method (c) test procedure is not recommended, for it does not test the adequacy of the suction supply to the water supply to pump suction (*see 5-1.5*).

A-5-3.5.2 When comparing test plot with original acceptance test plot, it should be recognized that the acceptance test plot could exceed the minimum acceptable pump requirements as indicated by the pump rated characteristics. While a lessening of output is a matter of concern, this condition must be evaluated in the light of meeting the pump rated characteristics.

A-5-5.1 It is most important to provide proper bearing lubrication and to keep bearings clean. Some bearings are the sealed type, requiring no relubrication. Couplings with rubber drive parts do not require lubrication; other types generally do. The following practices are recommended:

(a) Clean lubricant fittings before relubricating with grease.

(b) Use proper amount of lubricant. Too much results in churning, causing excessive power loss, and overheating.

(c) Use correct lubricant.

Engine Maintenance. Keep engines clean, dry, and well lubricated. Maintain the proper oil level in the crankcase.

Battery Maintenance. Use only distilled water in battery cells. Keep plates submerged at all times.

The automatic feature of a battery charger is not a substitute for proper maintenance of battery and charger. Periodic inspection will ensure that the charger is operating correctly, the water level in the battery is correct, and the battery is holding its proper charge.

Fuel Supply Maintenance. Keep the fuel storage tank at least two-thirds full. Fuel should be maintained free of water and foreign material by draining water and foreign material annually from the tank sump. This would require draining approximately 5 gallons.

Temperature Maintenance. Temperature of the pump room, pump house, or area where engines are installed should never be less than the minimum recommended by the engine manufacturer. Follow the manufacturer's recommendations for water and oil heaters.

Table A-5-2.2 Weekly Observations

Before Pump Is Run	
Horizontal Pumps.	1. Check drip pockets under packing glands for proper drainage. Standing water in drip pockets is the most common cause of bearing failure. 2. Check packing adjustment—should have approximately one drop per second to keep packing lubricated. 3. Observe suction and discharge gauges. Readings higher than suction pressure indicate leakage back from system pressure through either the fire pump or jockey pump.

Table A-5-3.2.4 Weekly Observations

While Pump Is Running	
Horizontal Pumps	1. Read suction and discharge gauges—difference between these readings will indicate churn pressure, which should match churn pressure as shown on fire pump name plate. 2. Observe packing glands for proper leakage for cooling of packing. 3. Observe discharge from casing relief valve—adequate flow will keep pump case from overheating.
Vertical Pumps	1. Read discharge gauge—add distance to water level in feet divided by 2.31 = psi. This total should match churn pressure as shown on fire pump name plate. 2. Observe packing gland for proper leakage for cooling of packing. 3. Observe discharge from casing relief valve—adequate flow will keep pump case from overheating.
Diesel Engines	1. Observe discharge of cooling water from heat exchanger—if not adequate check strainer in cooling system for obstructions. If still not adequate adjust pressure reducing valve for correct flow. 2. Check engine instrument panel for correct speed, oil pressure, water temperature, ammeter charging rate. 3. Check battery terminal connections for corrosion and clean, if necessary. After pump has stopped running check intake screens, if present, change diesel system pressure recorder chart, and rewind if required.

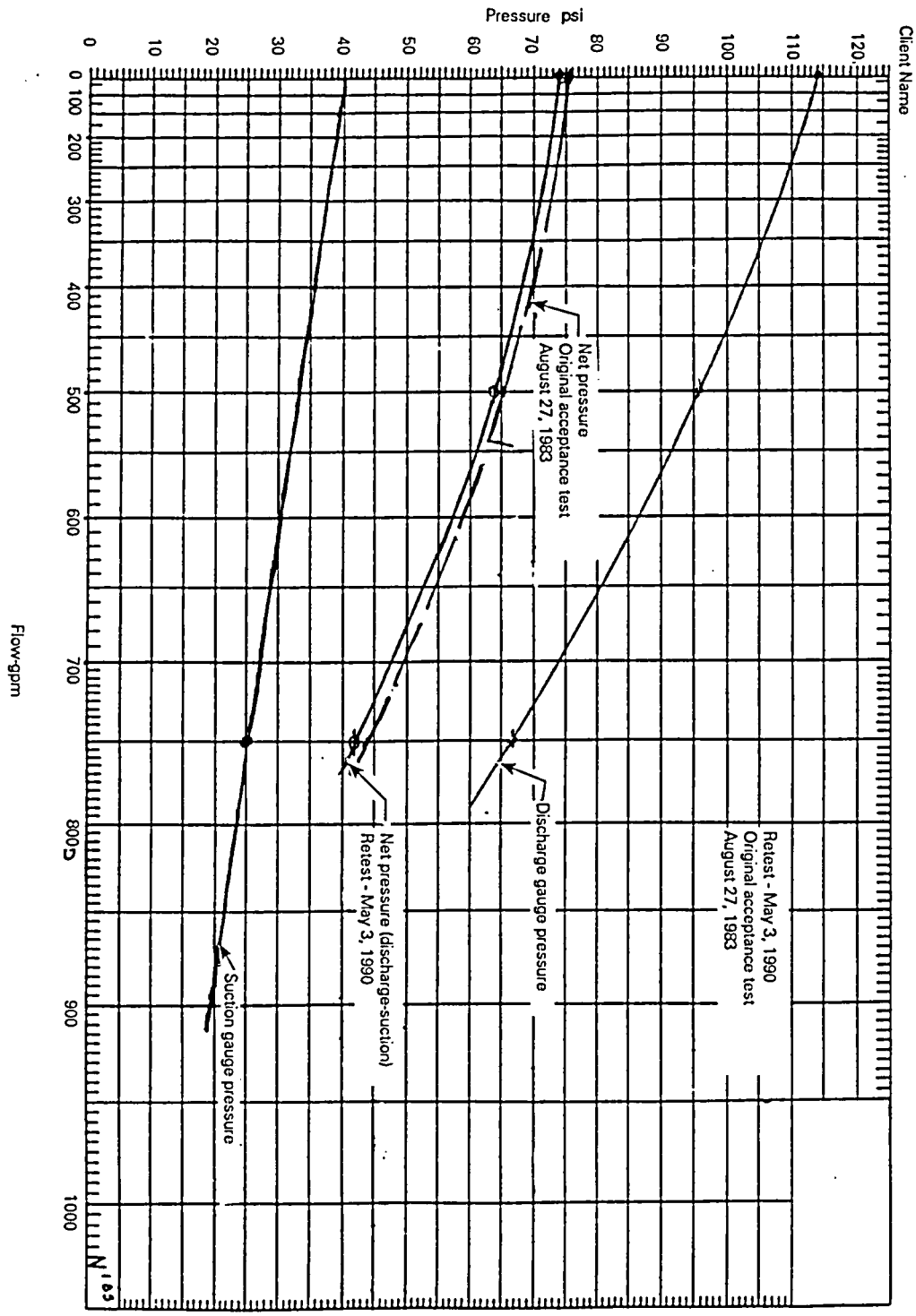


Figure A-5-3.5.2 Fire pump retest.

A-6-1.1 Types of storage tanks include wood and steel ground level and gravity (elevated) tanks, steel pressure tanks, and embankment supported fabric tanks.

(a) Steel or wooden gravity (elevated) tanks range in size from 5,000 to 500,000 gal (steel) or 5,000 to 100,000 gal (wood) and are generally on 75 to 150 ft towers. They provide water directly to sprinklers or standpipe systems.

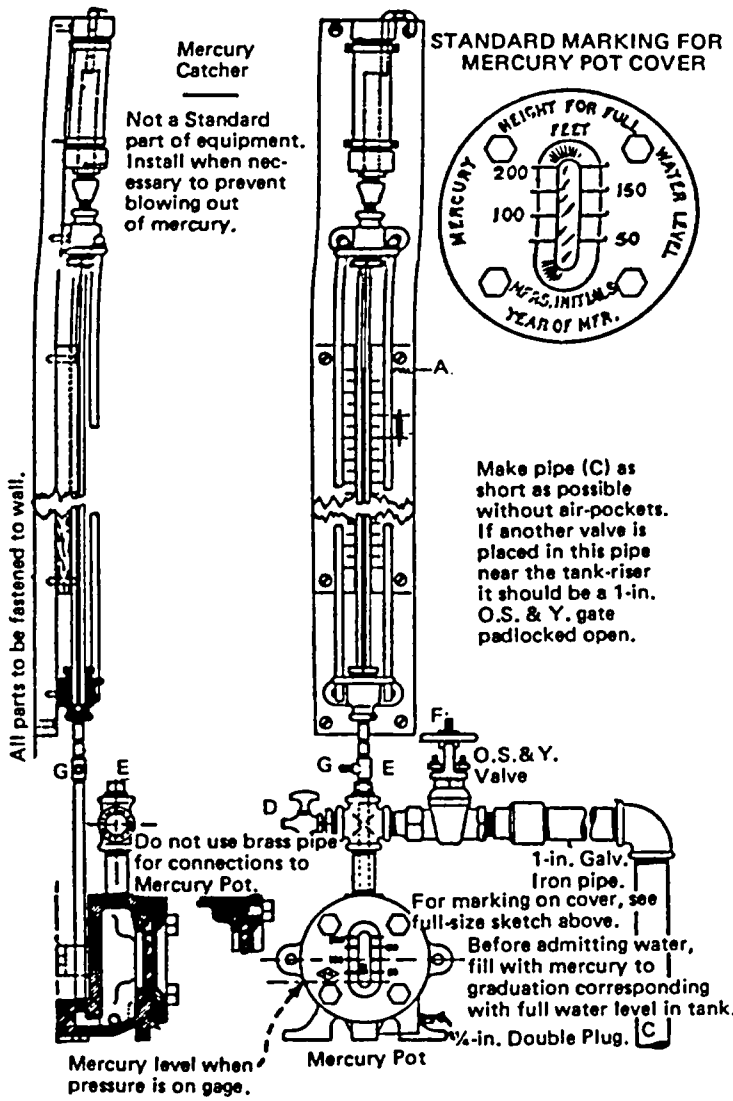
(b) Steel suction tanks providing water for fire pump installations. The tanks are at ground level and range from 50,000 to 1,000,000 gal in size.

(c) Steel pressure tanks provide water directly to sprinkler or standpipe systems. Limited in size (they are rarely larger than 9,000 gal) the tank is kept two-thirds full of water and then is pressurized with air to 75 psi. For large supplies, more than one tank is used.

(d) Embankment supported fabric tanks are used as suction sources for fire pumps. They range in size from 100,000 to 1,000,000 gal. Generally, the tank is composed of a liner with an integral flexible roof and is designed to be supported by an excavation or earthen berm.

A-6-2.1 More frequent inspections should be made where extreme conditions, such as freezing temperatures or arid climate, may increase the probability of adversely affecting the stored water.

A-6-2.2 Lightning protection systems, where provided, should be inspected, tested, and maintained in accordance with NFPA 78, *Lightning Protection Code*.



For SI Units: 1 in. = 25.4 mm; 1 ft = 0.3048 m.

Figure A-6-3.1 Mercury gauge.

A-6-3.1 Testing of listed mercury gauges as shown in Figure A-6-3.1.

(a) Overflow the tank.

(b) Close valve "F." Open test cock "D." The mercury should drop quickly into the mercury pot. If it does not, there is an obstruction that must be removed from the pipe or pot between the test cock and the gauge glass.

(c) If the mercury does lower at once as it should, close cock "D" and open valve "F." If the mercury responds immediately and comes to rest promptly opposite the "FULL" mark on the gauge board, the instrument is functioning properly.

(d) If the mercury column does not respond promptly and read correctly during the above test, there are probably air pockets or possibly obstructions in the water connecting pipe. Open cock "D." Water should flow out forcibly. Permit water to flow through cock "D" until all air is expelled and rusty water from the tank riser appears. Then close "D." The gauge should now read correctly. If air separates from the water in the 1-in. (25.4-mm) pipe due to being enclosed in a buried tile conduit with steam pipes, the air can be automatically removed by installing a ¾-in. (19-mm) air trap at the high point of the piping. The air trap can usually be best installed in a tee connected by a short piece of pipe at "E" with a plug in the top of the tee so that mercury can be added in the future, if necessary, without removing the trap. If there are inaccessible pockets in the piping, as when below grade or under concrete floors, the air can be removed only through petcock "D."

(e) If, in test (d), the water does not flow forcibly through cock "D," there is an obstruction that must be removed from the outlet of the test cock or from the water pipe between the test cock and the tank riser.

(f) If there is water on top of the mercury column in the gauge glass, it uses inaccurate readings and must be removed. First lower the mercury into the pot as in test (b). Close cock "D" and remove plug "G." Open valve "F" very slowly causing mercury to rise slowly and water above it to drain through "G." Close valve "F" quickly when mercury appears at "G," but have a receptacle ready to catch any mercury that may drain out. Replace plug "G." Replace any escaped mercury in the pot.

(g) After testing, leave valve "F" open, except as noted in the following:

If found necessary to prevent forcing mercury and water into the mercury catcher, the controlling valve marked "F" may be closed when filling the tank, but should be left open after the tank is filled. For cases when the gauge is subjected to continual fluctuation of pressure, it may be necessary to keep the gauge shut off except when reading. Otherwise it may be necessary to frequently remove water from the top of the mercury column as in (f) above.

A-6-3.4 The manufacturer's instructions should be consulted for guidance on testing. In some situations, it may not be possible to test the actual initiating device. In these cases, only the circuitry should be tested.

A-6-3.5 See A-6-3.4.

A-6-3.6 See A-6-3.4.

A-6-4.11 Where detailed manufacturer's instructions are not available, the following general maintenance guidelines should be followed:

(a) Flush out the water circulating pipe and heater in the fall before the heating season starts and about monthly during the heating season, depending upon the rate of sedimentation. After flushing, make sure that all valves are wide open and the drain valve closed.

(b) In the fall, check the adjustment of relief valves, steam regulators, pressure-reducing valves, thermostats, and safety pilots.

(c) At the end of the heating season, clean and overhaul heaters, traps, strainers, and other accessories. Take apart and replace gaskets of steam, electric, and hot-water heaters. Wire brush the steel or iron heating surfaces of coal-, fuel oil-, or gas-fired heaters, and coat with oil. Follow manufacturer's instructions regarding lubrication.

(d) Have gas-fired or oil-fired heaters serviced and inspected by a service organization during the summer.

(e) Every five years, usually when repainting the tank, disassemble radiator heaters and clean out all pipes. Replace badly corroded pipe with copper water tubing or brass (85 percent copper) or cast iron pipe.

(f) Every five years, clean the exterior of steam coils that are used to heat suction tanks. Steel or iron coils should be taken apart and cleaned inside. Replace seriously corroded coils with copper tubing or brass (85 percent copper) pipe.

(g) Coil-type gas heaters may require periodic removal of scale or lime deposits, since some solids exist in most water supply systems. As the water is heated, these solids tend to drop out. This condition can normally be detected when a change of approximately 5°F (2.8°C) in the normal temperature rise through the heater occurs. This scale is comparatively easy to remove if cleaned before the coils become clogged. Special solvents are available for this purpose. Manufacturers of approved coil-type water heaters have a preventive maintenance system for deliming. Their recommendations should be followed.

A-6-4.16 Repainting should be done only on dry surfaces thoroughly cleaned of all loose paint, rust, scale, or other surface contamination.

All interior surfaces of steel tanks exposed to water immersion or the vapor phase zone above the high water level should be cleaned by Near White Blasting per Steel Structures Painting Council (SSPC)-SP10 or Pickling per SSPC-SP8 and primed in accordance with the requirements for Inside Painting System No. 2 (wash primer per SSPC-PT3 plus one coat of vinyl per SSPC - Paint No. 9) or Inside Paint System No. 4 (one coat of vinyl paint per Bureau of Reclamation Specification VR-3) of AWWA Standard D102.

All exterior surfaces and inside dry surfaces (pedestal tanks) should be cleaned by commercial blasting per SSPC-SP6 or Pickling per SSPC-SP8 and primed with one coat of red lead alkyd per Type II or III of Federal Specification TT-P-86 or a suitable proprietary primer, all in accordance with the requirements for Outside Paint System No. 1 of AWWA Standard D102.

The appropriate primers for other interior and exterior paint systems should be permitted to be used, provided permission is first obtained from the authority having jurisdiction.

During repainting, all weld seams, unprimed margins, and any areas on which the primer (if pre-primed) has been damaged should be cleaned and patch primed with the same primer.

All finish coat painting for interior (wet) surfaces should be in accordance with the requirements for Inside Paint Systems No. 2 or No. 4 of AWWA Standard D102, utilizing the same basic system throughout. For System No. 2, one complete field coat of vinyl per SSPC - Paint No. 9 and two complete coats of vinyl aluminum per SSPC - Paint No. 8 should be used to provide a minimum total system dry film thickness of 4.5 mils (112 microns). As an alternate, the two final coats shall be permitted to be white vinyl per Bureau of Reclamation Specification VR-3 to provide a minimum total system dry film thickness of 5.0 mils (125 microns). A 5.0-mil (125-micron) minimum total thickness with one additional coat should be permitted to be specified by the purchaser. For System No. 4, three complete field coats in contrasting colors of vinyl paint per Bureau of Reclamation Specification VR-3 should be used to provide a minimum total system dry film thickness of 6.0 mils (150 microns).

All exterior and inside dry finish coat painting should be in accordance with the requirements for Outside Paint System No. 1 of AWWA Standard D102 utilizing two coats of aluminum or alkyd enamel in a color as specified by the purchaser to provide a minimum total system dry film thickness of 3.5 mils (87 microns) for aluminum finishes and 4.5 mils (112 microns) for alkyd enamels. As provided by Outside Paint System No. 4 of AWWA D102, the purchaser should be permitted to specify an extra complete coat of primer for a total minimum system dry film thickness of 5.0 mils (125 microns) for aluminum finishes and 6.0 mils (150 microns) for alkyd enamels for the more severe atmospheric exposures.

Other finish coats should be permitted to be used, provided they are compatible with the primers and provided permission is first obtained from the authority having jurisdiction.

Painting Application. All painting should be accomplished in accordance with the appropriate requirements of *Steel Structures Painting Council Paint Application Specification No. 1 (Shop, Field and Maintenance Painting).*

A-7-1.1 Insulation acting in lieu of water spray protection is expected to protect a vessel or structure for the duration of the exposure. For structural members, the insulation is to prevent the temperature from exceeding 850°F (454°C); for vessels, 650°F (393°C). If the insulation is found to be missing, the exposure protection for the structure or vessel is lost, regardless of water spray protection or insulation on other surfaces. To reestablish the proper protection, the insulation should be replaced or the water spray protection, at the appropriate density, should be extended.

A-7-1.2 Water spray fixed systems are most commonly used to protect processing equipment and structures, flammable liquid and gas vessels, piping, and equipment such as transformers, oil switches, and motors. They have also been shown to be effective on many combustible solids.

A-7-2.1 Water spray systems may use fixed temperature, rate-of-rise, rate-compensation fixed temperature, optical devices, flammable gas detectors, or products of combustion detectors, and manual means to initiate water flow.

A-7-2.3 There are two types of strainers. Pipeline strainers are used in water supply connections. These are capable of removing from the water all solids of sufficient size to obstruct the spray nozzles [normally 1/8-in. (3.2-mm) perforations are suitable]. Pipeline strainer designs should incorporate a flushout connection or should be capable of flushing through the main drain.

Individual strainers for spray nozzles, where needed, are capable of removing from the water all solids of sufficient size to obstruct that spray nozzle they serve.

A-7-2.5 The selection of the type and size of spray nozzles was made with proper consideration given to such factors as physical character of the hazard involved, draft or wind conditions, material likely to be burning, and the general purpose of the system.

High velocity spray nozzles, generally used in piped installations, discharge in the form of a spray filled cone. Low velocity spray nozzles usually deliver a much finer spray in the form of either a spray filled spheroid or cone. Due to differences in size of orifices or waterways in the various nozzles and the range of water particle sizes produced by each type, nozzles of one type cannot ordinarily be substituted for those of another type in an individual installation without seriously affecting fire extinguishment. In general, the higher the velocity and the coarser the size of water droplets, the greater the effective "reach" or range of the spray.

Another type of water spray nozzle uses the deflector principle of the standard sprinkler. The angle of the spray discharge cones is governed by the design of the deflector. Some manufacturers make spray nozzles of this type individually automatic by constructing them with heat responsive elements as used in standard automatic sprinklers.

A-7-4.4 The operation of the water spray system is dependent on the integrity of the piping, which should be kept in good condition and free of mechanical damage. The pipe should not be used for support of ladders, stock, or other material. When piping is subject to a corrosive atmosphere, a protective corrosion-resistant coating should be provided and maintained. When the age or service conditions warrants, an internal examination of the piping should be made. When it is necessary to flush a part or all of the piping system, this work should be done by sprinkler contractors or other qualified workers.

A-7-4.4.1 Rubber gasketed fittings in the fire areas are inspected to determine that they are protected by the water spray or other approved means. Unless properly protected, fire could cause loss of the rubber gasket following potentially excessive leakage in a fire situation.

A-7-4.4.2 Hangers and supports are designed to support and restrain the piping from severe movement when the water supply operates and to provide adequate pipe slope

for drainage of water from the piping after the water spray system is shut down. Hangers should be kept in good repair. Broken or loose hangers may put undue strain on piping and fittings, cause pipe breaks, and interfere with proper drainage of the pipe. Broken or loose hangers should be replaced or refastened.

A-7-4.5(A) Systems need inspection to ensure water spray nozzles will effectively discharge water unobstructed onto surfaces to be protected from radiant heat (exposure protection) or onto flaming surfaces to extinguish or control combustion. Factors affecting the proper placement of water spray nozzles include the following:

(a) Changes or additions to the protected area that obstruct existing nozzles or require additional coverage.

(b) Removal of equipment from the protected area that results in nozzle placement at excessive distances from the hazard.

(c) Mechanical damage or previous flow tests that have caused nozzles to be misdirected.

(d) A change in the hazard being protected that requires more or different nozzles to provide adequate coverage.

Spray nozzles may be placed in any position necessary to obtain proper coverage of the protected area. Positioning of nozzles with respect to surfaces to be protected, or to fires to be controlled or extinguished, should be guided by the particular nozzle design and the character of water spray produced. In positioning nozzles, care should be taken that water spray does not miss the targeted surface and reduce the efficiency or calculated discharge rate.

A-7-4.7.2 Each post indicator valve should be opened until spring or torsion is felt in the rod, indicating that the rod has not become detached from the valve. Valves should be backed one-quarter turn from the wide-open position to prevent jamming.

A-7-4.9 Mainline strainers should be removed and inspected for damaged and corroded parts at least every five years.

A-7-5.3.1 (a) Some detection circuits may be deliberately desensitized in order to override unusual ambient conditions. In such cases, the response in 7-5.3.1 may be exceeded.

(b) Testing of integrating tubing systems may be related to this test by means of a standard pressure impulse test specified by the listing laboratory.

(c) One method of testing heat detection uses a radiant heat surface at a temperature of 300°F (149°C) and a capacity of 350 watts at a distance of 1 but not more than 2 in. (50-mm) from the nearest part of the detector. This method of testing with an electric test set should not be used in hazardous locations. Other test methods may be employed, but the results should be related to the results obtained under these conditions.

A-8-3.10 Proportioning systems may or may not include foam concentrate pumps. If pumps are part of the proportioning system, the driver, pump, and gear reducer should be checked in accordance with the manufacturer's recommendations and may include lubrication, fuel, filters, oil levels, clutches, etc.

A-8-3.10.2 Liquid Tank Full. In some cases, an adequate supply of foam liquid may not be a full tank. This is particularly true of foam liquid stored in nonmetallic tanks. If liquid is stored in metallic tanks, the proper liquid level should be one-half the way up into the expansion dome.

A-8-3.10.3.1 CAUTION: Although under normal standby conditions this type of proportioning system should not be pressurized, some installations will allow for inadvertent pressurization. Remove pressure before inspection.

A-8-3.10.3.2 Bladder Tank Proportioners. When inspecting for liquid tank full, follow the manufacturer's instructions. If checked incorrectly, tank sight gauges may indicate a full tank when the tank is empty of foam liquid. Some foam liquids, due to their viscosity, may not indicate true levels of foam liquid in the tank when checked via the sight glass.

> **CAUTION:** Depending upon system configuration, this type proportioner system may be pressurized or nonpressurized under normal conditions. Remove pressure before inspection.

A-8-4 Operational test generally should be comprised of:

(a) A detection/actuation test with no flow to verify that all SUCH components operate such as automated valves, foam and water pumps, alarms, etc.

(b) A water-only flow test to check piping continuity, discharge patterns, pressures, and line flushing.

(c) A foam flow test to verify solution concentration.

(d) Resetting of system to its normal standby condition, including draining of lines, filling foam liquid tank, etc.

A-8-4.3 An alternate method to achieve flow may be an installation as shown in Figure A-8-4.3. This type of testing does not verify system pipe conditions or discharge device performance, only the water supply, foam concentrate supply, and proportioning accuracy.

A-8-4.3.4 Specific foam concentrates are typically listed or approved with specific sprinklers. Part of the approval and listing is a minimum sprinkler operating pressure. Sprinkler operating pressure affects foam quality, discharge patterns, and fire extinguishment (control) capabilities. Discharge pressures less than this minimum specified pressure should be corrected immediately; hence the need to test under full flow conditions.

A-8-5 Maintenance. The maintenance items specified in the body of this standard are in addition to the typical inspection and test procedures indicated. Foam-water systems are, as all fire protection systems, designed to be more or less maintenance free. There are, however, some areas that require special attention. Foam concentrate shelf-life varies between liquids and is affected by such things as heat, cold, dilution, and contamination, to mention a few. As with all systems, common sense will dictate those maintenance-sensitive areas that must be attended to. Routine testing and inspection will generally dictate the need for additional maintenance items. Those detailed items specified under maintenance are key items that should be routinely performed.

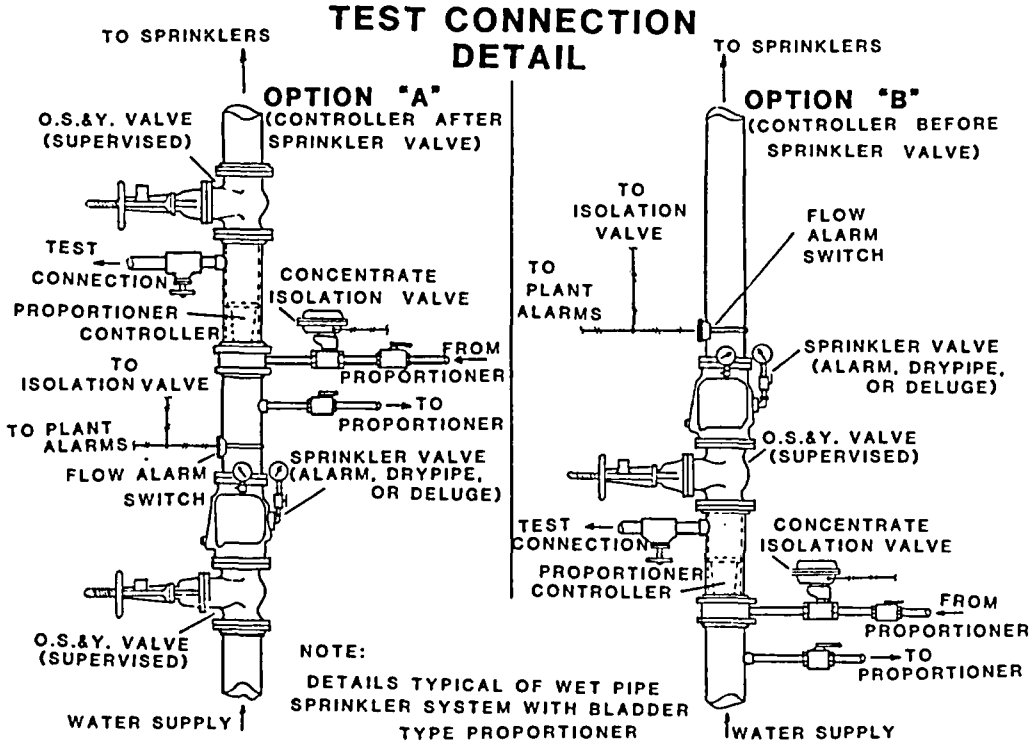


Figure A-8-4.3 Foam system/test header combination.

A-8-5.1(b) Foam concentrates will tend to sediment out over time. Depending on the specific characteristics of the foam concentrate, sedimentation will accumulate in the bottom of the storage vessel. This sediment may affect proportioning and foam concentrate validity. Some concentrates will tend to settle out more rapidly than others. If the annual samples indicate, excessive sediment flushing of tank may be required on a more frequent basis.

A-8-5.2(b) When hydrostatically testing bladder tanks, do not allow the generation of a pressure differential across the diaphragm. The manufacturer should be consulted for specific procedures.

A-9-1 Application of Valves and Fire Department Connections.

1. Alarm Valves. Alarm valves are installed in water-based fire protection systems to sound a fire alarm when a flow of water from the system equals or exceeds the flow of a single discharge device.

A retarding chamber, which minimizes false alarms due to surges and fluctuating water supply pressure, may be supplied with the alarm valve.

2. Backflow Prevention Devices. Backflow prevention devices are used to prevent water in a fire protection system from entering the public water supply due to a reverse flow of water, thermal expansion, hydraulic shock, back pressure, or back siphonage.

3. Ball Valves. Ball valves are manually operated through their full range of open to close with one-quarter turn.

4. Butterfly Valves. Water supply control valves with gear operators to assist in opening and closing. Butterfly valves may be wafer or grooved end.

5. Check Valves. Check valves allow waterflow in one direction only.

6. DCA. A double check assembly consists of two independently operating spring loaded check valves. The assembly includes two resilient seated isolation valves and four test cocks required for testing.

7. DCDA. A double check detector assembly is hydraulically balanced to include a metered bypass assembly to detect system leakage. The main valve assembly and bypass assembly afford equal levels of backflow prevention and are each equipped with two resilient seated isolation valves and four test cocks required for testing.

8. Deluge Valves. Deluge valves hold water at the valve until actuated by the operation of a detection system or manual release.

9. Drip Valves. Drip valves automatically drain condensation or small amounts of water that have leaked into system piping or valves. Drip valves close when exposed to system pressure.

10. Dry Pipe Valves. Dry pipe valves control the flow of water to areas that may be exposed to freezing conditions. Water is held at the valve by air pressure in the system piping. When the air pressure is reduced, the valve operates and floods the system.

11. Indicating Valves. Indicating valves provide a dependable, visible indication of the open position, even at a distance.

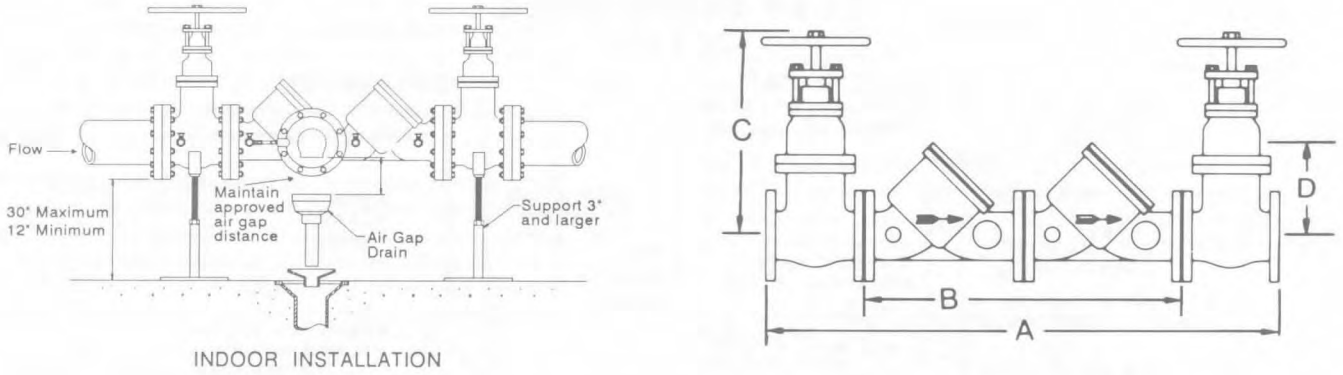


Figure A-9-1(a) Reduced pressure backflow preventers (left), and double check valve assemblies (right).

12. **Indicator Posts.** Indicator posts include wall and underground types and are intended for use in operating inside screwed pattern gate valves and for indicating the position of the gates in the valves.

13. **Nonrising Stem Gate Valves, Outside Screw, and Yoke Gate Valves.** Nonrising stem (NRS) gate valves are used underground with indicator posts attached or as roadway box valves (curb-box installation). Outside screw and yoke (OS&Y) gate valves are used indoors and in pits outdoors. The valve stem moves out when the valve is open and in when it is closed. The stem indicates the position of the valve.

14. **RPA.** A reduced pressure zone principle assembly consists of two independently spring loaded check valves separated by a differential sensing valve. The differential sensing valve includes a relief port to atmosphere that discharges excess water resulting from supply system fluctuations. The assembly includes two resilient seated isolation valves and four test cocks required for testing.

15. **RPDA.** A reduced pressure detector assembly is hydraulically balanced to include a metered bypass assembly to detect system leakage. The main valve assembly and bypass assembly afford equal levels of backflow prevention, and each assembly is equipped with two resilient seated isolation valves and four test cocks required for testing.

16. **Strainers.** Strainers are used for protection against clogging of water discharge openings.

17. **Waterflow Detector Check Valves.** Detector-type check valves allow flow in one direction only and have provisions for the connection of a bypass meter around the check valve.

A-9-2.6 Main drains are installed on system risers for one principal reason: to drain water from the overhead piping after the system is shut off. This allows the contractor or plant maintenance department to perform work on the system or to replace nozzles after a fire or other incident involving system operation.

These drains are also used to determine if there is a major reduction in waterflow to the system, such as might be caused by a major obstruction, a dropped gate, an almost totally closed valve, or a check valve clapper stuck to the valve seat.

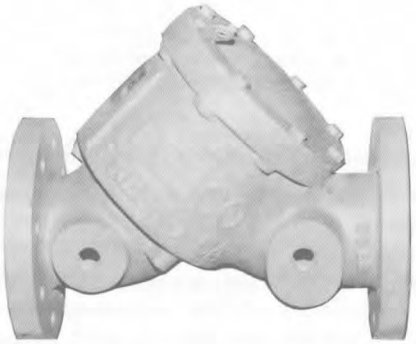


Figure A-9-1(b) Detector check valve.

A large drop in full flow pressure of the main drain (as compared to previous tests) will normally be indicative of a dangerously reduced water supply caused by a valve in the almost fully closed position or other type of severe obstruction. After closing the drain, a slow return to normal static pressure will confirm the suspicion of a major obstruction in the waterway and will be reason to determine the cause of the variation.

A satisfactory drain test (one that is in agreement with previous tests) does not necessarily indicate an unobstructed passage, nor does it mean that all valves in the upstream flow of water are fully opened. The conduct of drain tests does not substitute for a valve check on 100 percent of the fire protection valving.

The main drain test is conducted in the following manner:

(a) Record pressure indicated by the supply water gauge.

(b) Close the alarm control valve on alarm valves.

(c) Fully open the main drain valve.

(d) After the flow has stabilized, record the residual (flowing) pressure indicated by the water supply gauge.

(e) Close main drain valve (slowly).

(f) Record the time required for supply water pressure to return to the original static (nonflowing) pressure.

(g) Open the alarm control valve.

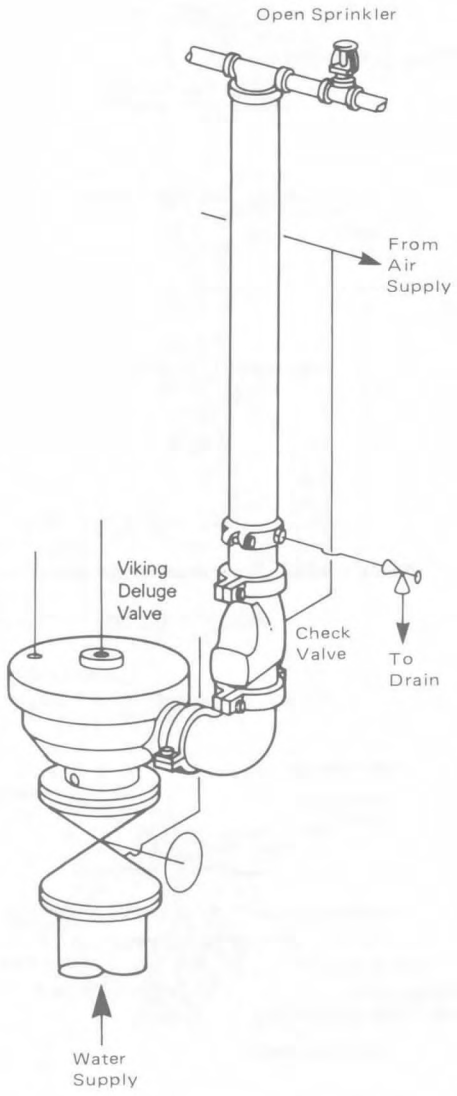


Figure A-9-1(c) Deluge valve—Viking.

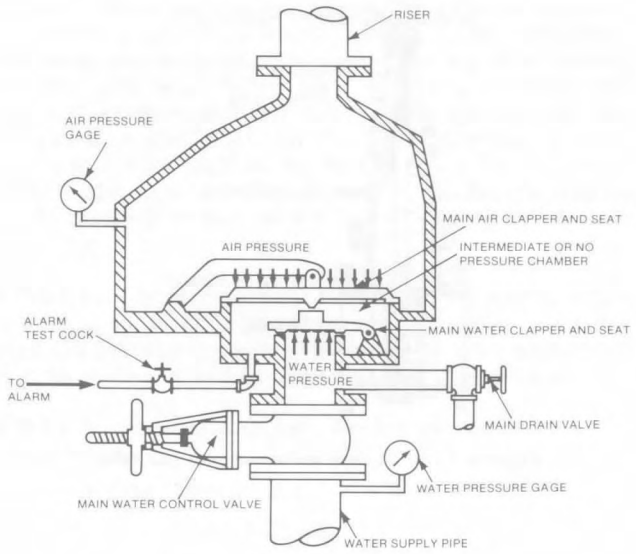


Figure A-9-1(d) Dry pipe valve.

Figure A-9-1(e) Butterfly post indicator valve (courtesy of Henry Pratt Company).

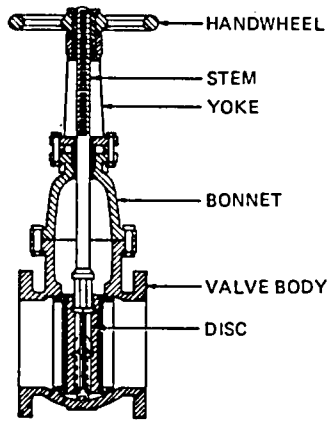


Figure A-9-1(f) Outside screw and yoke gate valve.

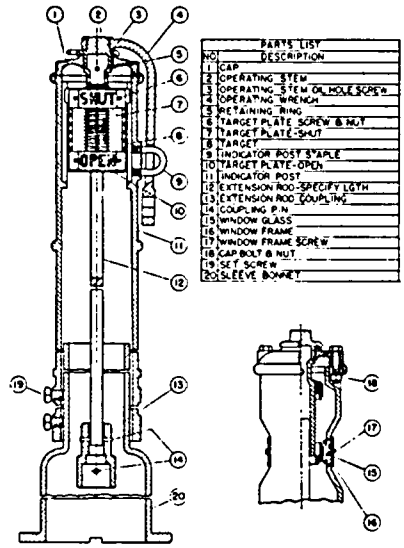


Figure A-9-1(g) Vertical indicator post.

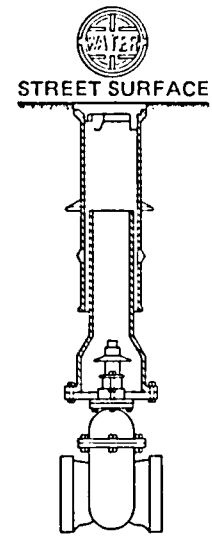


Figure A-9-1(h) Nonindicating type gate valve.

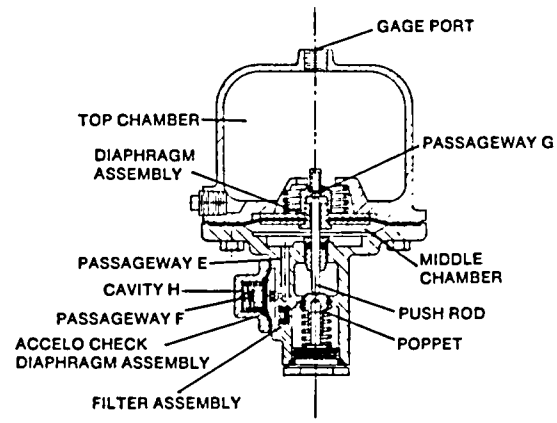


Figure A-9-1(i) Dry pipe system accelerator from Reliable Automatic Sprinkler Co.

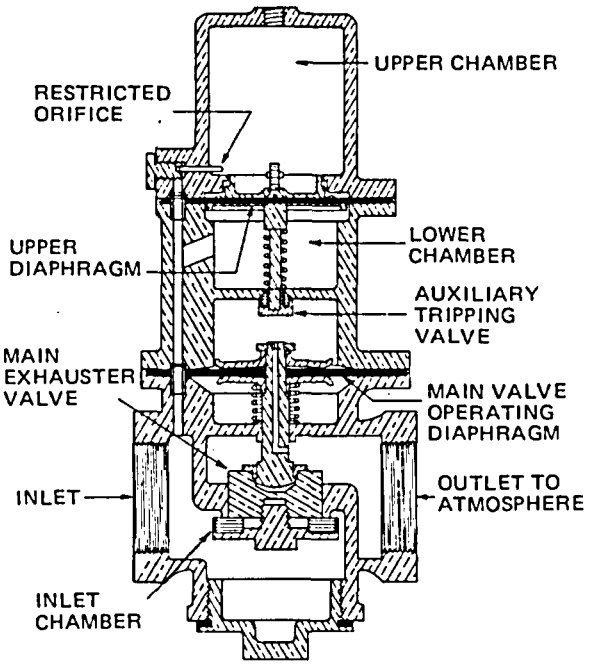


Figure A-9-1(j) Dry pipe system exhauster.

A-9-3.1 Closed control valves statistically result in approximately 30 percent of water-based fire protection system failures.

A-9-3.2 Signs identifying underground fire service main control valves in roadway boxes should indicate the direction of valve opening, distance, and direction of the valve from the sign location (if the valve is subject to being covered by snow or ice), and the location of the wrench if not located with the sign.

A-9-3.2.1 Valves that are normally closed during cold weather should be removed and replaced with devices that will provide continuous fire protection service.

A-9-3.3.2 Valves should be kept free of snow, ice, storage, or other obstructions so that access is assured.

A-9-3.3.2(b) The purpose of the valve sealing program is (1) the presence of a seal on a control valve is a deterrent to closing a valve indiscriminately without obtaining proper authority to do so, and (2) a broken or missing seal on a valve will be reason for the plant inspector to verify that protection is not impaired and to notify superiors of the fact that a valve may have been closed without following procedures.

A-9-3.4.2 These "spring tests" are made to verify that a post indicator valve is fully open. When the operator feels the valve is fully open, he/she should push in the "open" direction. The handle should move a short distance (one-quarter turn or so) and "spring" back toward the operator in a subtle move when released. This spring is caused when the valve gate pulls up tight against the top of its casting and the valve shaft (being fairly long) twists a little. The "spring" indicates that the valve is fully opened and that the gate is attached to the handle. If the gate were jammed due to a foreign particle, the handle should not "spring" back. If the gate were lose from the handle, the handle would continue to turn in the "open" direction with little resistance.

A-9-4.1.1 A higher pressure reading on the system gauge is normal in variable pressure water supplies. Pressure over 175 psi may be caused by fire pump tests or thermal expansion and should be investigated and corrected.

A-9-4.1.2 Drain system for internal inspection of valve components.

(a) Close the control valve.

(b) Open the main drain valve.

(c) Open the inspector's test valve.

(d) Wait for the sound of draining water to cease and for all gauges to indicate 0 psi before removing the handhole cover or dismantling any component.

A-9-4.3.2.1 High priming water levels can adversely affect the operation of supervisory air. To test the level, open the priming level test valve. If water flows, drain it. Close the valve when water stops flowing and air discharges. If air discharges when the valve is opened, the priming water level may be too low. To add priming water, refer to the manufacturer's instructions.

A-9-4.3.2.2 Preaction and deluge valves in areas subject to freezing should be trip tested in the spring to allow time before cold weather for all water that has entered the system or condensation to drain to low points or back to the valve.

A-9-4.3.2.9 Methods of recording maintenance include tags attached at each riser, records retained at each building, and records retained at one building in a complex.

A-9-4.3.3.3 Suitable facilities should be provided to dispose of drained water. Low points equipped with a single valve should be drained as follows:

(a) Slowly open the low point drain valve.

(b) Close the drain valve as soon as water ceases to discharge and allow time for additional accumulation above the valve.

(c) Repeat this procedure until water ceases to discharge.

(d) Replace plugs or nipple and caps as necessary.

Low points equipped with dual valves should be drained as follows:

(a) Close the upper valve.

(b) Open the lower valve and drain the accumulated water.