FIRE PROTECTION SYSTEM INSPECTION, TESTING AND MAINTENANCE AND OTHER FIRE LOSS PREVENTION INSPECTIONS

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1.0 SCOPE

This data sheet provides guidelines for establishing a fire protection equipment inspection program and guidance for testing and maintaining privately owned fire protection equipment.

For design and installation details for the various types of systems addressed in this data sheet, refer to the applicable FM Global Property Loss Prevention Data Sheet.

1.1 Changes

April 2017. Interim revision. Minor editorial changes were made.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Introduction

Fire protection systems, when properly designed and installed, provide an effective means of protecting property against fire. Only a comprehensive inspection, testing and maintenance program can help ensure satisfactory system operation and performance during an emergency.

It is equally important that, when inspection, testing and maintenance operations are carried out, proper planning and impairment procedures are followed to minimize the time systems are out of service, and to have in place a means to readily return the systems to service in the event of an emergency during the course of these procedures. Coordination with the in-house emergency response team as well as close supervision of any outside contractors performing these services are essential to minimize the hazard involved and reducing the risk to the facility.

Appendix C contains sample forms that can be used for various types of equipment. When necessary, customized forms may be useful, depending on the type of equipment involved.

2.1.1 Fire Protection System Impairment Precautions

Whenever fire protection water supplies, sprinklers, fire pumps or special protection is impaired for any reason, an unusual fire protection hazard exists, and specific fire prevention procedures are necessary. Note that routine testing of fire protection equipment can create an impairment to the system, and even these brief impairments need to be properly managed. Follow procedures based upon the FM Global Red Tag Permit System and as outlined in Section 3.1.1 to ensure complete precautionary measures are taken and ignition sources are controlled.

2.1.2 Qualified Personnel

2.1.2.1 Qualified Employees for Inspections

The value of fire protection equipment inspections depends primarily on the reliability and competence of the employees performing them. Employees who conduct fire prevention inspections must be familiar with the entire fire protection system. In addition to knowing the location of the fire protection control valves they must know what systems the valves control and how each type of system operates. They must also be able to detect abnormal conditions that could create fire protection equipment impairments and recognize common defects in housekeeping or occupancy conditions that could increase fire probability or severity. Inspectors must have management's full backing in having the deficiencies they report promptly corrected.

More than one designated inspector is needed so inspections can be continued without interruption by illness, vacations, or transfers. Often, two or more people are trained to inspect on alternate weeks so abnormal conditions are less likely to be overlooked.

2.1.2.2 Outside Contracted Services

Any outside contracted services must operate under the direction of facility personnel to ensure such services are adequate from a scope and frequency standpoint and that all impairment precautions are properly carried out. The purpose of outside contracted services is to maintain and even improve the excellent record of fire protection by providing knowledgeable and capable inspection, testing, and maintenance functions. Such services are of particular value to properties that do not have qualified personnel, or a well-established program of their own for keeping fire protection equipment in dependable operating condition. The facility has the responsibility to arrange for the contractor to carry out the desired periodic inspections and tests of fire protection equipment and to provide a written report. Copies of the report and recommended improvements must be sent by the contractor to the appropriate facility personnel as well as any other involved parties. For additional guidance reference Data Sheet 10-4, *Contractor Management*.

2.1.3 Precautions Against Freezing

To minimize exposures to those facilities that may be exposed to freezing weather, establish an active cold weather readiness program. Follow the guidelines in Data Sheet 9-18, *Prevention of Freeze-Ups*.

Cold weather brings the danger of impaired fire protection as a result of water freezing in fire protection equipment. This leaves a facility vulnerable to a fire when the fire protection system is impaired due to extended repair times, and water leakage from ruptured or frozen fire protection system components.

2.2 Fire Protection System Inspection, Test, and Maintenance Frequencies

Table 1 is a quick reference summary of the recommended inspection and testing frequencies for most fire protection system components. The listed reference provides the location of additional information about the component and the recommended action.

Table 1. General Fire Protection Inspection Frequency Reference.

Frequency	*Component*	*Action*	*Reference*
Weekly	Sprinkler Valves	Inspect	Table 2
	Dry/Deluge/Pre-action Systems	Inspect	Table 3
	Fire Pump	Test	Table 6
	Water Tank	Inspect	Section 2.3.16
	Open Water Supply Suction Screens	Inspect	Section 2.3.16.2
	Pressure Reducing Valves	Inspect	2.3.11
	Special Protection Systems	Inspect	Table 8
	Fire Prevention Inspection	Inspect	Section 2.5.1
Monthly	Sprinkler Valves	Inspect/Physically Try	Table 2
	Dry/Deluge/Pre-action Systems	Inspect/Test Alarms	Table 3 & Section 2.3.5
	Fire Pump Diesel Engine	Inspect Batteries	Table 6
	Pressure Reducing Valves	Operational Test	2.3.11
Quarterly	Sprinkler Water Flow Alarms	Test	Section 2.3.2
	Standpipes and Hose	Inspect	Section 2.3.15
Semi-Annually	Freezer Protection Systems	Inspect	Section 2.3.7
	Special Protection Systems	Check Agent Quantity	Table 8
	Fire Pump Diesel Engine	Maintenance	Table 6
Annually	Sprinkler Valves	Close and Reopen	Table 2
	Dry/Deluge/Pre-action Systems	Partial Trip Test	Table 3
	Fire Hydrant Control Valves [1]	Inspect/Physically Try	Section 2.3.1.3
	Main Drain	Test	Section 2.3.9
	Fire Hydrants	Flow Test	Section 2.3.10
	Back-flow Preventers	Flow Test	Section 2.3.12
	Fire Pumps	Flow Test	Table 6
	Fire Pump Diesel Engine	Maintenance	Table 6
	Open Water Supply Suction Screens	Clean	Section 2.3.16.2
	Pressure Reducing Valves	Flow Test	Section 2.3.11
	All Special Protection Systems	Test Detectors and Actuators	Table 8
	All Special Protection Systems	Inspect and Clean Nozzles	Table 8
	Gaseous Protection Systems	Inspect Protected Area	Table 8
	Foam Water Sprinkler System	Test	Table 8
	Dry Chemical	Inspect for Agent Caking	Table 8
Every 3 Years	Dry/Deluge/Pre-action Systems	Full Flow Trip Test	Table 3 & Section 2.3.5
	Freezer Protection Systems	Internal Inspection	Section 2.3.7
	Underground Main Loop	Flow Test	Section 2.3.10
Every 5 years	Sprinkler Systems with an Open Reservoir Suction Source	Flushing Investigation	Section 2.3.14.1
	Check Valves, Alarm Valves, and Backflow Preventers	Internal Inspection	Sections 2.3.3 & 2.3.12
	Steel Water Tanks	Internal Inspection	Section 2.3.14
Every 10 Years	Dry/Deluge/Pre-action Systems [2]	Flushing Investigation	Table 3
	Sprinklers	Inspect	Section 2.3.8

[1] Increased to weekly for unprotected buildings, exposure protection, or combustible yard storage.

[2] Increased to every 5 years after 20 years of service.

2.3 Water-Based Fire Protection Systems

2.3.1 Fire Protection System Control Valves

2.3.1.1 Unauthorized Valve Closures

Fire protection system control valves require primary attention since a closed valve at the time of a fire can lead to a loss of all or a major portion of the protected facility. Take strong measures to reduce the possibility of a control valve being closed without authorization, both before and during a fire.

Improperly closed valves are most likely to occur when additions or renovations are made to a fire protection system. Often, individuals working on the system are unaware that the control valve must not be operated without first notifying responsible personnel. In other cases, there is no one assigned the responsibility of ensuring that proper valve impairment procedures are followed.

Implement a valve supervision program that insures the following:

1. The valves are locked in the wide/full open position.
2. Valve inspections are made (visual inspection and physically trying the valves as applicable).
3. The valve inspection list is complete and the inspection form is carried by the inspector during the inspection.
4. The Red Tag Permit System for valve closures is used by employees and contractors (see Section 3.1.1, Fire Protection System Impairment Precautions).
5. Main drain tests are made after a valve is reopened.

2.3.1.2 Valve Locking

All fire protection system control valves larger than 1-½ in. (38 mm) or those controlling more than five sprinklers are required to be locked open where they are under the direct control of the building owner or tenant. This includes electrically supervised valves. Where it is difficult to install and maintain locks on curb box valves, a less desirable alternative is to lock all curb box ”T“ wrenches. See Section 3.1.2 for valve-locking methods.

Until valves are locked, they are required to be sealed open unless electrically supervised. It is preferable that valves 1-½ in. (38 mm) or smaller or those controlling five or fewer sprinklers are locked open, but an acceptable alternative is to seal them open.

Ensure locks and chains used as securing devices are sturdy and resistant to breakage except by heavy bolt cutters. Do not use breakaway or combination locks.

Where exposed to weather or in valve pits, ensure locks are corrosion resistant and are kept well lubricated.

Keep the distribution of valve lock keys to an absolute minimum and restricted to only those individuals directly responsible for the fire protection system.

2.3.1.3 Valve Inspections

Inspect all fire protection system water control valves at the frequencies outlined in Table 2. Section 3.1 describes appropriate techniques for conducting valve inspections. The intent of the inspections is to ensure fire protection valves remain in an open, locked, operable and accessible condition.

Inspect fire hydrant control valves annually unless the hydrants are the only means of fire protection at the facility or if the hydrants are required for hose stream protection of outdoor hazards such as combustible yard storage, outdoor chemical processes, or adjacent property exposure protection, then inspect hydrant control valves as outlined in Table 2.

Table 2. Valve Inspection Frequency Guidelines

Valve Type	*Action*	*Frequency*
Outside screw and yoke (OS&Y), Indicating butterfly valves (IBV's), Post indicator valve assemblies (PIVA's)	Visually inspect for the full open position and locked.	Weekly
	Full turn operation, return to and re-lock in the full open position, and conduct drain test. **Note 1 & 2**	Annually
Post indicator valve (PIV), Wall post indicator valve (WPIV), Inside screw gate valves	Visually inspect for the open position and locked.	Weekly
	Physically test for the full open position and re-lock in the full open position. **Note 1**	Monthly
	Full turn operation, return to and re-lock in the full open position, and conduct drain test. **Note 1 & 2**	Annually
Curb-box/roadway	Visually inspect cover and for accessibility.	Weekly
	Physically test for the full open position and leave in the full open position.	Monthly
	Full turn operation, return to the full open position, and conduct drain test. **Note 1 & 2**	Annually

NOTE 1: Any physical test or full-turn operation will likely activate any tamper switch that is electrically supervised. Take proper precautions to ensure the alarm station is notified both before and after any operation of the valve(s).

NOTE 2: Annual full turn operation creates an impairment condition and needs to be handled as a planned impairment utilizing the Red Tag Impairment Kit. (see Section 3.1.1, Fire Protection System Impairment Precautions)

2.3.2 Sprinkler Water Flow Alarms

Test all water flow alarms at a minimum frequency of quarterly. In large facilities it may useful to stagger testing so a certain number of alarms are tested every month with the end result being that all alarms are tested quarterly.

Ensure that testing is conducted by well-trained facility personnel or by a qualified inspection service. Any outside contracted services must be under the direction of facility personnel to ensure such services are adequate from a scope and frequency standpoint and that all impairment precautions are properly carried out during the performance of such services. Take precautions to avoid unnecessary local disturbances and response by the public fire service.

Do not turn off fire pumps or isolate pumps from fire protection systems during water flow alarm testing unless the pump(s) is not required for sprinkler adequacy. Proper fire protection impairment handling procedures need to be followed if pump impairment is unavoidable.

In wet-pipe systems, use the inspectors test connection at the extreme end of the system. Ensure that this connection has an orifice size equal to the size of a single sprinkler and therefore provides a minimum flow test of the alarm. In systems such as those in high-rise buildings where there is a test connection integral with the water supply connection feeding the sprinklers on each floor, the water flow alarm test can be made at the sprinkler system feed for each floor.

In dry-pipe systems, use the hydraulic test connections at the dry-pipe valve riser. (See Section 3.1.4, Dry Pipe Systems)

Small valves controlling the water supply to pressure switches or other alarm devices need to be sealed or locked in the open position. Ensure that the valves are included on the alarm testing form and indicate if the valve was open or closed.

In freezing weather, take precautions to prevent ice from accumulating in areas were it could become a hazard.

2.3.3 Alarm Check Valve

Verify that alarm check valves reset properly after water flow alarm testing. Inspect wet alarm check valves internally for corrosion every 5 years.

2.3.4 Dry-Pipe Systems

Dry-pipe valves require more inspection, testing and maintenance than wet-pipe systems because of their greater complexity and susceptibility to internal corrosion. Preventive maintenance and inspection of these systems is an essential part of a good loss prevention control program. Besides ensuring proper operation during a fire, regular dry-pipe system maintenance helps prevent unnecessary false trips and freeze-ups.

In addition to normal water control valve inspections, follow the inspection and testing guidelines in Table 3.

Additional information is provided in Section 3.1.4.

Table 3. Dry-Pipe System Inspection and Testing Guidelines.

Frequency	*Action*
Weekly **NOTE 1**	1. Check to ensure system air and water pressures are adequate. 2. Verify that air supply valves to accelerators and exhausters are open, accelerator/exhauster air pressure is equalized with system air pressure, and excess water is drained off. 3. Make sure the valve room/house temperature is at a minimum of 40°F (5°C).
Monthly	1. Verify that the automatic drain (ball drip valve) from the intermediate chamber is free to move. 2. Check the level of priming water above the clapper and drain any excess water. 3. Make sure no air leakage is occurring. 4. Check the operability of accelerators and exhausters without tripping the dry pipe valve. 5. Check the condition of air compressors and air dryers (if required). Follow manufacturers recommended maintenance schedule for these components. 6. Before and during cold weather check the sprinkler systems low point drains and drain as necessary.
Annually **NOTE 2**	Partial Flow Trip Test — Record air and water pressure. With the water control valve closed perform a partial flow dry pipe valve trip test using the inspectors test connection to exhaust the air. Record the time and air pressure at which the system trips and compare to previous tests. If the time has increased, investigate and fix the deficiency. Drain the system and inspect internal dry pipe valve components. Clean, repair and replace components as necessary. Reset the dry pipe valve per the manufacturers instructions, making sure the water and air pressures are normal and that the air supply system is working properly. Check and service the air dryer (if provided) based on the manufacturer's guidelines. Perform a 2 in. (51 mm) drain test after the dry pipe valve is placed back in service.
Every 3 Years **NOTE 2**	Perform a full flow trip test in the same manner as the annual partial flow trip test, but with the water control valve fully open. Compare the results with previous full flow trip times. Ensure that the valve trips and water arrives at the inspectors test connection within 60 seconds. Observe condition of the water. Conduct a flushing investigation if scale or debris sufficient to clog a sprinkler is evident. Restore to service in the same manner as for the annual partial flow trip test.
Every 10 Years **NOTES 2, 3, 4, & 5**	Perform a flushing investigation on plain (black) steel pipe systems. See Table 7 for additional frequency detail. See Section 3.1.5.3 for flushing investigation procedure. See Note 5 below for galvanized piping systems.

NOTE 1. During extreme cold weather (-20°F [-11°C] below normal low temperature) check the temperature of the valve room/house and the air and water pressures daily.
NOTE 2. This test can create an impairment condition and needs to be handled as a planned impairment utilizing the Red Tag Impairment Kit. (See Section 3.1.1, Fire Protection System Impairment Precautions)
NOTE 3. Reduced to every 5 years after 20 years of service.
NOTE 4. Systems in service for 20 years or longer with no history of flushing investigation maintenance are likely obstructed and a full flushing is required.
NOTE 5. For internally galvanized piping systems flushing investigations are only required if the suction source is an open water supply or if obstructions are suspected.

2.3.5 Deluge and Preaction Systems

All applicable dry pipe inspection and maintenance frequencies apply (Table 3).

Test supervisory trouble signals monthly.

Test fire detection system annually as outlined in Data Sheet 5-48, *Automatic Fire Detectors.*

Trip-test and inspect deluge and preaction systems annually. If water damage will result from a full flow test, systems can be tripped with a partially closed (throttled) control valve.

Employ a qualified contractor to make any necessary repairs and adjustments. Keep records of the valve trip test at the valve specifying details of the test method and results (e.g., detection system used, trip time, and who did the testing.)

Where thermo-pneumatic actuated preaction or deluge systems are exposed to freezing temperatures, check the condition of the drying agent annually.

Where the system is not exposed to freezing temperatures, check the drying agent every three years. The drying agent of older systems is checked by weighing the canister. If the weight of the canister and alumina exceed the manufacturer's recommended limits, replace the alumina or dry it in an oven. The drying agent is usually blue, indicating calcium sulfate; it turns pink or white when it needs replacing.

2.3.6 Antifreeze Automatic Sprinkler Systems

Test sprinkler systems utilizing antifreeze solutions to prevent freezing annually by measuring the solution's specific gravity. If required, add additional antifreeze to the sprinkler system until the specific gravity is greater than or equal to the values given in Tables 4 and 5.

Table 4. Antifreeze Solutions to be used if potable water is connected to sprinklers.[1]

Material	*Solution (by volume)*	*Specific Gravity at 60°F (15.6 °C)*	*Freezing Point*	
			°F	°C
Glycerine C.P. or U.S.P. Grade*	50% Water	1.133	-15	-26.1
	40% Water	1.151	-22	-30.0
	30% Water	1.165	-40	-40.0
Hydrometer Scale 1.000 to 1.200				
Propylene Glycol	70% Water	1.027	+9	-12.8
	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 Pharmacopoeia 96.5%.
[1] Reprinted with permission from NFPA 13, *Installation of Sprinkler Systems,* Copyright ©2006, National Fire Protection Association, Quincy, MA 02169. this reprinted material is not the complete and official position of the National Fire Protection Association on the referenced subject which is represented only by the standard in its entirety.

Table 5. Antifreeze solutions to be used if non-potable water is connected to sprinklers.[1]

Material	*Solution (by volume)*	*Specific Gravity at 60°F (15.6°C)*	*Freezing Point*	
			°F	°C
Glycerine	If glycerine is used, see Table 4			
Diethylene Glycol	50% Water	1.078	-13	-25.0
	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 Glycol	61% Water	1.056	-10	-23.3
	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 4			

†Free from magnesium chloride and other impurities.
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2.3.7 Refrigerated Area Automatic Sprinkler Systems

Dry automatic sprinkler systems within refrigerated areas and freezers with constant temperatures below 32°F (0°C) have a history of obstruction problems from ice plug formation. An FM Approved double-interlock refrigerated area sprinkler system with an appropriately arranged and maintained dried air supply significantly reduce the risk of ice plugs within automatic sprinkler piping. Ice plugs are most prevalent within 10 ft (3.0 m) of the point where the sprinkler piping enters the freezer environment. Also, the first elbow or tee fitting in the freezer, regardless of proximity to the point of entry, is a common point of ice formation and needs to be inspected.

1. Check automatic sprinkler piping within freezer environments for ice plugs between 4 and 6 months after commissioning. Where an appropriately arranged and maintained dried air supply is provided and no ice build-up is present in the sprinkler piping, perform a re-inspection within one year. After two consecutive years of ice plug inspection with no problems developing, this inspection procedure can be extended to 3 years subject to any problems developing during the interim period (e.g., false trips, air compressor problems, poor maintenance of air dryer systems/components, etc.). Verify proper facility maintenance and inspection of refrigerated area automatic sprinkler system components, including air dryer systems.

2. If problems with ice plugs are encountered following the initial commissioning period or beyond, identify the icing source and take corrective action. Where ice plug problems exist, conduct internal inspections more frequently until corrections are completed for the compressed air supply system (maximum 6 month intervals).

3. When ice plugs are discovered, consider the automatic sprinkler system involved impaired until repairs are made.

Additional guidance and reference information can be found in Data Sheet 8-29, *Refrigerated Storage*.

2.3.8 Sprinklers

Sprinklers in clean locations may be expected to give good protection indefinitely, however after they have been in service for 10 years conduct a close examination. Exposure to adverse conditions may in time reduce performance or may result in unnecessary water damage by premature opening. Recognition of these conditions and proper remedies are essential to effective protection. If any of the conditions outlined below appear, remove representative sprinklers and have them tested.

2.3.8.1 Sprinkler Overheating

Ensure the sprinkler temperature rating is appropriate for the occupancy, which is typically 50°F (28°C) above ambient. For additional guidance, see Section 3.1.6.

Changes in occupancy that may affect room temperatures, such as increased drier temperatures, installation of new heat-producing equipment, overhead heating coils or unit heaters, frequently cause premature opening of sprinklers through overheating. When such changes are made, install sprinklers of higher ratings, if needed.

Following a fire, replace all non-operated sprinklers within 20 ft (6 m) of any operated sprinklers.

2.3.8.2 Sprinkler Freezing

Freezing may cause sprinklers to operate prematurely. Indications of freezing are difficult to detect. Depending upon the type of sprinkler, the evidence may be reduced link tension, metal gaskets forced upward, bent hook pieces, tilted glass or metal buttons, badly dished or distorted diaphragms, or bent struts.

2.3.8.3 Sprinkler Leakage

Slow leaking sprinklers will typically show evidence of leakage by a green or white deposit or discoloration around the orifice seal. Replace sprinklers exhibiting this condition as the water leakage can cause corrosion and mineral deposits that can impair sprinkler operation.

2.3.8.4 Sprinkler Corrosion

Test or replace sprinklers that show signs of external corrosion or are suspected of having internal corrosion. See Section 3.1.6 for additional information.

2.3.8.4.1 Protection Against Corrosion

Ensure that sprinklers installed in areas containing corrosive atmospheres or vapors are suitably protected against corrosion. When selecting sprinklers ensure that the corrosive environment and the sprinkler frame and heat responsive element or factory coating materials are compatible with the corrosives. Ensure the sprinkler is made of compatible corrosion resistant materials or is factory coated to prevent corrosion from the environment. See Section 3.1.8 for additional information.

2.3.8.5 Sprinkler Mechanical Injury

Ensure that sprinklers subject to possible impact from normal material handling and facility operations are mechanically protected. FM Approved sprinkler guards are one method of protection.

If a sprinkler is subjected to an impact, the damage may not be sufficient to cause immediate opening but may cause trouble later. It is best to replace such a sprinkler with a new one. Replace sprinklers that have bent or dented deflectors or cracked glass bulbs. Replace any glass bulb type sprinkler that has a clear bulb (no color present).

2.3.8.6 Sprinkler Loading

Ensure sprinklers are free of accumulations of process residue.

In certain occupancies, spray or other residue collects on sprinklers, forming a loading that may interfere with prompt sprinkler operation. It may be possible to protect sprinklers in confined areas such as paint spray booths where rapid heat buildup or flash fires can be expected, with a coating of medium-heavy grease or with the use of thin plastic or paper bags. Periodically wipe off and replace the protective grease coating or replace the bags. Do not cover sprinklers in open areas with bags or grease. Rapid sprinkler operation in such areas depends on convective heat, and covering them will retard operation.

In occupancies such as core oven rooms of foundries, cumulative long-term loading, possibly involving all sprinklers in the room, may interfere with prompt sprinkler operation. Residues of this type cannot be effectively removed. Replace all affected sprinklers.

2.3.8.7 Sprinkler Painting

Replace sprinklers that have paint overspray accumulations from ceiling painting or occupancy processes with new sprinklers and ensure suitable measures are taken to prevent a reoccurrence. Even small amounts of paint can interfere with the free movement of parts or thermal response and render the sprinklers inoperative.

2.3.8.8 Used Sprinklers

Do not install used sprinklers. Install only new sprinklers. Used sprinklers may be unreliable due to non-obvious mechanical damage, reduced link tension, weakened soldered members or hardened or oxidized solder.

2.3.9 Main (2 inch) Drain Testing

Flow the main 2 in. (50 mm) drain valve at each sprinkler riser at least annually. Investigate any of the following conditions: an observed rapid loss of pressure, lower than typical residual pressures, or failure for the pressure to restore itself promptly after the drain valve is closed. Repeat the drain test after the problem has been corrected.

Maintain records of the riser static and residual pressures during each main drain test for comparison from year to year.

Always conduct a main drain test after an upstream sprinkler valve has been impaired to verify that water flow to the sprinklers has been restored. (See Section 3.1.1 for impairment handling procedures) Also conduct a drain test after known or suspected work on municipal water mains, if the facility fire protection water is supplied from this source.

Conduct a main drain test weekly during periods of extreme freezing weather (20°F [10°C] below normal low temperatures for more than a week) to verify that water in the feed piping has not frozen.

2.3.10 Yard Hydrants and Underground Mains

Flow hydrants annually to ensure there are no obstructions in the piping or other problems. Ensure dry barrel hydrant weep holes are clear and water drains from the barrel properly.

Every three years, conduct performance flow tests on yard mains, isolating and checking each “leg” of looped underground systems. Investigate any unexplained differences in observed flow and pressure that would indicate a shut valve or obstruction in the underground main.

See Data Sheet 3-10, *Installation and Maintenance of Private Fire Service Mains and Their Appurtenances* for additional guidance.

2.3.11 Pressure Reducing Valves

Conduct weekly visual inspections, monthly operational testing, and annual full flow testing of pressure reducing valves in accordance with FM Global Data Sheet 3-11, *Pressure Reducing Valves*.

2.3.12 Backflow Preventers

Conduct annual full-flow testing of backflow preventers flowing at least the system demand. These tests are best conducted by a qualified contractor, and it may be required in some areas that the tester be licensed. Conduct internal inspection for debris and corrosion every 5 years.

2.3.13 Exposure Protection

Conduct annual flow tests on open sprinkler systems installed outside buildings for exposure or hazard protection.

These tests are recommended to determine whether the piping and sprinklers are plugged and are otherwise in good condition. The tests also allow a visual evaluation of the effectiveness of the water curtain. Take suitable precautions to provide adequate drainage so the water cannot enter the building or otherwise cause damage. Clean or replace any sprinklers or piping determined to be obstructed. Consider the risk of electrical shock when testing open sprinkler systems protecting outdoor transformers and switchgear and employ alternative inspection and test methods as appropriate.

2.3.14 Fire Pumps

Do not isolate pumps from the fire protection systems during weekly start tests or annual flow performance testing unless there is a secondary fully adequate water supply source that remains connected to the system during testing. Follow proper fire protection impairment procedures if the pump must be isolated.

Table 6. Fire Pump Inspection, Testing and Maintenance Guidelines

Frequency	*Item*
Weekly	Start the pump driver in the automatic mode (or the manual mode if that is the normal starting method), either by pressure drop, or by water flow (if that means is the primary automatic start feature), or manual start means(if that is the primary start feature). Do the following before running the weekly start test: - For diesel engine-driven pumps, check the crankcase oil level and quality to ensure it is adequate, and if not replenish. Also, check to make sure the engine block heaters are working properly. - Make sure suction and discharge pressure readings are proper. - Make sure wet pit suction screens and bar racks are unobstructed and in place. If pump suction is taken from open water, make sure the pipe and intake are located so they will at all times be completely below frost level underground and deep enough in the water to prevent their being obstructed by ice. Keep intake screens clear of ice obstructions. - Fire pump suction reservoirs or wet pits may develop a foot or more of ice covering during the winter. If a potential for vacuum conditions exists during water draw- down, maintain a hole in the ice by steam injection, water bubbling or other reliable means. - Overflow suction tanks or check them visually. - Make sure in cold weather that adequate heat is provided to the supply lines and the suction source. - Confirm fuel tank is ¾ full for diesel pump installations, and fuel inlet valve to the engine is in the open and locked condition. - Confirm adequate heat is provided in the pump room/house. This is generally 40°F (5°C). Ensure the following during weekly pump testing: - For diesel engine driven pumps, run the engine at rated speed for at least 30 minutes. - For electric motor-driven pumps, run the motor at rated speed for at least 10 minutes. - Make sure there is adequate water flow from any pump packing glands, that temperature is not excessive, and that there is not excessive water flow past the pump packings. Also check the following: - Circulation relief valve, pressure relief valve and heat exchanger (when provided for diesel engine-driven pumps) discharge line are flowing properly. - Confirm ventilation for diesel engine drivers is working properly. - Condition of batteries and battery charger, and electrolyte level. - Record gauge/meter readings (suction/discharge pressure, driver rpm, oil pressure, engine coolant temperature, amps, etc.) - Change pressure recorder chart. - Pump controller set for automatic start.
Monthly	Check the specific gravity of the electrolyte for diesel engine batteries.
Semi-annually	Replace diesel engine oil filter. If the oil is fouled or has lost viscosity, replace the engine oil.
Annually	- For diesel engines change the oil and the oil filter. - For diesel fuel tanks remove any accumulated water. - Lubricate coupling and right angle gear drive (if provided). - Check pump coupling alignment. Correct if necessary. - Check diesel engine coolant protection level and also the condition of the coolant fluid. Correct and replace as necessary. - Conduct water flow tests to obtain three test points (churn, 100 and 150 capacity) by actually flowing water (no re-circulating to pump suction). Ensure proper fire protection impairment procedures if the pump is isolated. Compare the test results with previous test points and if any deterioration in performance is noted, find the problem and correct it without delay. - Include the following readings during flow tests: voltage/amperage and rpm for electric driven pumps, rpm, cooling water temperature, and oil pressure for diesel driven pumps. - Confirm the pump controller is arranged for manual stop only and the unit does not cycle on/off during flow testing. Additionally, make sure by testing to start the pump that the emergency manual start feature is operational. - Confirm the pump is electronically supervised (loss of power, running condition, failure to start cranking cycle, overspeed failure, etc.) and alarms are operating properly. - Confirm that suction pressure regulating devices, if provided, are operating properly. - Confirm proper start pressure for the fire pump and start/stop pressures for the jockey pump. - Check wet pit bar racks and suction screens and clean as necessary after the test. - Leave the pump in the automatic start position.

2.3.15 Standpipe and Hose Systems

Visually inspect valves, hose, piping, and cabinets quarterly to ensure equipment is in good condition and accessible. Test any pressure reducing valves in accordance with FM Global Data Sheet 3-11, *Pressure Reducing Valves*.

2.3.16 Water Storage Tanks and Fire Pump Suction Supplies

Weekly, for pump suction tanks or reservoirs, pressure tanks or gravity tanks, report if any of the following conditions are not being met: (a) full; (b) heating system in use; and (c) adequacy of temperature at cold water return. Ensure that the water temperature is maintained at 42°F (6°C) or higher.

Inspect ferrous metal tanks for internal corrosion every 5 years. Remote camera inspection or other means not requiring the tank to be drained is the preferred method. If corrosion activity is evident, measure the wall thicknesses at several points around the tank using x-ray, ultrasonic, or equivalent non-destructive techniques. Compare the wall thicknesses with nominal values. In the event that the tank requires interior cleaning and restoration, this long duration impairment needs to be managed and precautions taken as outlined in Section 3.1.1, *FM Global Red Tag Permit System and Impairment Precautions*.

Whenever water supplies for fire protection service are supplied from an open body of water, the potential for obstructing material to enter fire protection piping systems will exist. The exposure level will vary depending on multiple factors such as construction features of the water containment body, arrangement and protection features of the intake piping/wet pits, surrounding terrain, frequency of cleaning activities, etc.

For locations where open bodies of fire protection water exist, conduct the following maintenance and inspections:

1. Conduct an obstruction investigation on all automatic sprinkler systems every 5-years through visual inspection and/or hydraulic flushing investigation methods. Where automatic sprinkler systems have pendent style automatic sprinkler systems, physically remove several sprinklers at multiple locations on the system and check for obstructions in the sprinkler and any pipe drops.

Where the second flushing investigation (at 10 years) determines there are no obstruction problems in the automatic sprinkler systems, the investigation frequency can be extended to every 10 years. However, if problems are observed during follow-up visits through flowing of fire pumps, yard mains, 2 in. drains or Inspector's Test Connections, reinstate the 5 year flushing investigation frequency.

2. Verify proper screens and bar racks are installed on vertical fire pump wet pit intakes and are inspected weekly and cleaned annually. Clean suction screens on the pump intake bowls annually when the wet pit is cleaned.

2.3.17 Internal Pipe Corrosion

Perform the following to slow internal corrosion in automatic sprinkler systems.

- Purge air pockets from wet systems following system draining;
- Use die-electric unions between dissimilar metals to prevent galvanic corrosion;
- Use corrosion resistant piping such as galvanized or stainless steel for dry systems;
- If corrosion is suspected conduct water analysis and inspect pipe interior.

See Section 3.1 for additional information.

Locations with an existing pipe corrosion problem are advised to seek qualified assistance to develop a comprehensive corrosion mitigation plan. Reference FM Global Data Sheet 2-1, *Corrosion in Automatic Sprinkler Systems,* for additional guidance.

2.3.18 Chemical Cleaners and Corrosion Inhibitors.

In general, the use of chemical cleaners and corrosion inhibitors are to be discouraged.

Piping cleaning treatments and corrosion inhibitors for the purpose of halting identified corrosion activity have proven to be troublesome when used in fire protection systems. The introduction of a treatment solution into a sprinkler piping network with dead-end pipe runs and pendent drops can result in a large variation of solution concentrations and exposure time throughout the system. Consistent concentration levels and full removal of the treatment solution and any dislodged pipe scale are necessary to ensure a successful system treatment. This has proven to be very difficult in practice for sprinkler systems. Most vulnerable to these treatments are pendent sprinkler heads, which can serve as low points for the collection of stratified treatment chemicals, pipe scale, or both. This can result in accelerated sprinkler corrosion (leaks) or restricted sprinkler orifices.

2.4 Fire Protection System Obstructions

2.4.1 General

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 a fire occurs and the sprinklers are plugged, the fire may not be extinguished or controlled. In such a situation, the fire may grow to uncontrollable size resulting in greater fire damage, causing excessive sprinkler operations and threatening the structural integrity of the building. In a worst case, the building may be completely destroyed.

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.

2.4.2 Obstruction Prevention

Conduct obstruction investigations in accordance with Table 7. Section 3.1.5 contains information regarding obstruction sources and techniques for carrying out flushing investigations as well as full flushing procedures.

If a dry or preaction system has been in service for 20 years or more, there has not been any flushing or investigative work conducted on the system, and the area protected is unheated, then a full flushing is warranted.

Table 7. Frequencies for Flushing Investigations.

Type of System and Conditions	*Piping Type*	*Frequency*
Dry Pipe and Preaction fed from Clean Water Supply	Uncoated Ferrous Sprinkler Piping	After in service for 10 years, after 20 years, and every 5 years thereafter.
Dry Pipe and Preaction fed from Clean Water Supply	Internally Galvanized Ferrous Sprinkler Piping	Flushing investigations for galvanized piping systems are only needed when the water supply is from an open body of water or when obstructing materials are suspected.
Wet, Dry Pipe or Preaction fed from Open Water Supply (e.g., ponds, rivers, etc.)	Any	Every 5 years. (See Section 2.4.2.2)
Dry Pipe or Preaction fed from Open Water Supply(e.g., ponds, rivers, etc.) where system is tripped more than 2 times per year.	Any	Annually (See Section 2.4.2.2)
When any of the following conditions exist: - Discharge of obstructive material is noted during a yard main water test. - Foreign material is noted in fire pumps, dry pipe valves or check valves. - Plugging of pipe or foreign material noted coming from Inspector's Test Connection. - Failure to flush underground piping or surrounding public mains following new installations or repairs. - Plugged sprinklers or piping found during building alterations or after a fire. - Defective intake screens for fire pumps taking suction from open bodies of water.	Any Sprinkler System or Underground Piping	As soon as the condition is discovered.

2.4.2.1 Dry-Pipe and Preaction Systems – Scale Prevention

Do not convert a dry system to a wet system seasonally.

After a trip, use compressed air to drive residual water out of the system.

Use internally galvanized piping for new dry-pipe and preaction sprinkler system installations.

Repair and minimize air leaks to reduce introduction of additional oxygen.

The use of inert gas, such as nitrogen, will reduce or eliminate the amount of oxygen in the system, and will likely be beneficial in reducing corrosion that can result in scale formation.

2.4.2.2 Fire Protection Systems Fed from an Open Water Supply

Conduct a flushing investigation of wet and dry sprinkler systems fed from open water supplies every 5 years.

Obstructing materials may be drawn into the fire protection system 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 also are common. In addition to checking piping, examine pendent sprinklers and pipe drops to make sure they are not obstructed.

Annual flushing is warranted when the system trips more than two times during a 12 month period. The rapid flow of water caused by a valve trip can draw in obstructing materials.

2.5 Special Hazard Protection Systems

Maintain systems in operating condition at all times and restore to service promptly after any impairment or operation. Manage all impairments and take precautions as outlined in Section 3.1.1, *FM Global Red Tag Permit System and Impairment Precautions.*

Establish and follow a program of scheduled inspections, tests and maintenance as indicated in Table 8.

Table 8. Special Protection System, Inspection, Testing and Maintenance Guidelines

Type of System	*Action*	*Frequency*
All Systems	Verify the system is being inspected, tested and maintained in accordance with the system manufacturer's guidelines. FM Approved systems are required to include a manual containing this guidance.	General
	Inspect to see that nozzles or discharge devices are clear and in proper position, all operating controls are properly set, and components have not been damaged.	Weekly
	1. Inspect and test all actuating and operating devices. Ensure that actuation/release devices are electronically supervised. Test pressure-operated devices, preferably by a complete or partial discharge. Maintain regular service contracts with the manufacturer or authorized representative. 2. Inspect pressurized agent containers and system components for conditions such as corrosion or pitting in excess of manufacturer's limits, structural damage, fire damage, repairs by soldering, welding or brazing. Replace the affected part(s) or hydrostatically test in accordance with the recommendations of the manufacturer and/or the original certifying agency. 3. Retrain facility personnel who may be called on to inspect, test, maintain, operate, or restore the system.	Annually
CO_2 Systems	Ensure the following: 1. High-pressure cylinders are fully charged in place and properly secured. 2. For low-pressure storage unit, that liquid level gauge indicates tank is full/normal, that pressure gauge shows normal pressure (300 psi [21 bar]), that the tank shutoff valve is open, and that pilot pressure supply valve is open. 3. Carbon dioxide storage is connected to discharge piping and actuators. 4. All manual actuators and pull stations are in place and tamper seals are intact. 5. Nozzles are connected, properly aligned, and free from obstructions and foreign matter. 6. Detectors are in place and free from foreign matter and obstructions. 7. System release panel is connected and showing "normal-ready" condition.	Weekly
	Verify carbon dioxide cylinders are being weighed every 6 months, with weights recorded and date of last hydrostatic test noted. A weight decrease of more than 10% requires refilling.	Semiannually
	Verify complete functional testing of all system operating controls/components (exclusive of system discharge) is being conducted at least annually preferably via a system service contract with the system manufacturer or his authorized representative/system installer. Check applicable inspection, testing and maintenance report.	Annually
	Hydrostatically test all CO_2 cylinders, valve assemblies, hoses and fittings, check valves, zone valves, manifolds at an interval not to exceed 12 years.	Every 12 years
Water Mist Systems	Reference Data Sheet 4-2, *Water Mist Systems* for specific system inspection and testing information.	

Type of System	*Action*	*Frequency*
Foam and Foam-Water Sprinkler Systems	1. Visually inspect the systems as part of the weekly fire protection equipment inspection program. Include all foam control valves on the sprinkler control valve list as part of the valve supervision program. 2. Test run foam concentrate pumps. (see Table 6)	Weekly
	1. For all pre-primed closed-head AFFF systems: drain, flush and re-prime the system. 2. Inspect the stored foam concentrate for an excessive increase in viscosity (sludging) or deterioration. Send samples to the manufacturer or qualified laboratory for quality/condition testing. Replace foam if expired. Verify there is proper quantity in the tanks or containers. 3. Verify the foam proportioning system is satisfactorily tested annually. Ensure that foam-water sprinkler systems are provided with a test connection to avoid the need to flow foam solution through the system discharge piping. Deviations of more than 10% from prior testing results need to be corrected. 4. Thoroughly inspect all mechanical and electrical foam system components and individually check for proper operation.	Annually
Dry Chemical Systems	Immediately after use, all hand-hose lines need to be blown clear of dry chemical to prevent the possibility of plugging upon subsequent operation.	After Any Use
	Verify the correct quantity of expellant gas by cylinder pressure or weight. The minimum acceptable limitation of expellant gas varies with the design of the equipment and is indicated on the system nameplate. In stored pressure systems, check the pressure gauge to determine that the pressure is in the operable range.	Semiannually
	1. Check the dry chemical in gas-cartridge or cylinder pressurized systems to make sure it is free-flowing and without lumps. 2. When annual inspection of the dry chemical containers or system components reveals conditions such as corrosion or pitting in excess of manufacturer's limits, structural damage, fire damage, repairs by soldering, welding or brazing, replace the affected part(s) or hydrostatically test in accordance with the recommendations of the manufacturer and/or the original certifying agency.	Annually
	Check the dry chemical in stored pressure (normally pressurized) systems to make sure it is free flowing and without lumps.	Every 6 years
	Hydrostatically test all dry chemical containers less than 150 lb (68 kg) nominal capacity (based on sodium bicarbonate agent), auxiliary pressure containers, valve assemblies, hoses and fittings, check valves, directional valves, manifolds, and hose nozzles at an interval not to exceed 12 years. Do not reuse the dry chemical removed from the container prior to testing. During such testing, ensure preventive measures are taken to minimize the probability of a fire unless a connected reserve is provided. Dry all equipment thoroughly prior to recharging.	Every 12 years

Type of System	*Action*	*Frequency*
Clean Agent and Halon 1301 Systems	Check the agent quantity and pressure of clean agent containers. Refill or replace halocarbon clean agent containers if they show a loss in agent quantity of more than 5% or loss in pressure (adjusted for temperature) of more than 10%. Refill or replace inert gas clean agent containers if they show a loss in pressure (adjusted for temperature) of more than 5%.	Semiannually
	1. Inspect and test the system for proper operation exclusive of a discharge test. Inspect and test all actuating and operating devices in accordance with the system manufacturer's recommendations as outlined in the appropriate system design, installation, operation and maintenance manual. Regular service contracts with the system manufacturer's authorized representative are recommended. 2. Inspect the protected enclosure to determine if penetrations or other changes have occurred that could adversely affect agent leakage or change the volume of the protected space or both. Correct any conditions discovered during the inspection that could result in the inability to maintain the clean agent concentration. If uncertainty still exists with regard to the enclosure integrity, conduct an enclosure integrity test of the enclosure. **Note:** Keep a record of all changes made to or within the protected enclosure to facilitate the inspection and maintenance of the enclosure integrity. Maintain clean agent systems in operating condition at all times and restore to service promptly after any impairment or operation. Manage impairments using the FM Global *Red Tag Permit System* (See Section 3.1.1). Seal any penetrations made through the clean agent system protected enclosures immediately.	Annually
Water-Spray Fixed Systems	Conduct an annual water flow test of all systems. Where a flow test is not practical, conduct operational tests of at least the automatic water control valves and of all initiating devices (heat detectors, etc.).	Annually

2.6 Property Loss Fire Prevention Inspections

In addition to the previously recommended inspections, make regular inspections covering other vital aspects of fire prevention. Tailor the inspection report to the individual facility, including only those items that would apply. Provide a space on the report to record details of deficiencies and any special hazard conditions. Include a space on the form for the inspector's signature and that of management responsible for taking action to correct any deficiencies. Correct those deficiencies that can be quickly remedied (e.g., blocked fire doors) during the inspection. Record these deficiencies as a reminder for preventive action.

2.6.1 Weekly Fire Prevention Inspections

Complete the following items, where applicable, during a weekly fire prevention inspection (See Appendix C, *Fire Protection Inspection Form*):

1. Ensure all fire protection systems are in service.
2. Inspect for changes in occupancy that have increased the fire hazard.
3. Inspect fire doors and indicate if found in good order. Ensure the door can move freely and exercise it if possible. Report any doors that are blocked open or inoperative.
4. Record the sprinkler system water pressure. Check to see that it is consistent on the various pressure gauges, allowing for check valves and excess pressure pumps.
5. Sprinkler inspection: a) needed or disconnected; b) obstructed by high-piled storage; c) signs of leakage; d) pipe hanger missing or damaged, or e) located near broken windows or open doors that may permit freezing.

6. Check general housekeeping conditions and report deficiencies. Note separately conditions in: a) storage areas; b) painting or other ignitable liquid areas; c) combustible dust, oil or lint deposits on ceilings, structural members or machines; and d) other areas, including yard storage.
7. Check ignitable liquid storage and handling areas for: a) use of safety cans where needed; b) excessive storage in manufacturing areas; c) obstructed drainage facilities; and d) use of ventilation fans, automatic closing faucets, safety bungs and grounding straps where needed.
8. Report violations of smoking regulations.
9. For Hot Work operations, provide space to report if permits are being used where required and whether the listed precautions are being taken.
10. Report any defects noted in electrical equipment.
11. Report storage that blocks aisles or fire protection equipment, or is too near heaters or lights.
12. Inspect inside hose stations to ensure that all equipment is in place and in good condition. Repair hose racks or reels that show signs of mechanical damage.
13. Report excessive accumulation of waste material.
14. Report any accumulations of snow, water, dirt or other materials on roofs or floors that could lead to overloading or collapse.
15. Report any leaks or other indications that roof needs repair.

2.6.2 Other Regular Inspections

1. Check nozzle angles of directional water spray and special hazard protection systems annually. Also remove, clean or replace system and nozzle strainers, if provided.
2. Annually test fire detection systems (heat and smoke) as outlined in Data Sheet 5-48, *Automatic Fire Detectors*.
3. Maintain, inspect and test portable fire extinguishers at intervals recommended in Data Sheet 4-5, *Portable Extinguishers*.
4. Trip test fire doors and lubricate moving parts annually.
5. Inspect and flow yard hydrants annually and pressure test fire hose as outlined in Data Sheet 3-10, *Installation and Maintenance of Private Fire Service Mains and Their Appurtenances*.

3.0 SUPPORT FOR RECOMMENDATIONS

Recommendations are based mainly on FM Global's years of field experience related to fire protection system inspection and maintenance problems and loss history.

3.1 Supplemental Information

3.1.1 FM Global Red Tag Permit System and Impairment Precautions

Whenever fire protection water supplies, sprinklers, fire pumps or special protection is impaired for any reason, an unusual fire protection hazard exists, and specific fire prevention procedures are necessary. Note that routine testing of fire protection equipment can create an impairment to the system, and even these brief impairments need to be properly managed. Follow procedures based upon the FM Global Red Tag Permit System and as outlined below to ensure complete precautionary measures are taken and ignition sources are controlled.

1. Is any hot work (i.e., cutting, welding, brazing, grinding) being allowed in an unprotected area? If so, cease this potential ignition source while fire protection is impaired.
2. Is smoking allowed in the unprotected area? If so, stop all smoking until fire protection has been restored to service.
3. Are there hazardous operations in the impaired area? If so, can this operation be stopped until fire protection is back in service? This could include ignitable liquids and dusts in the area.

4. If this is a planned impairment, is all the pre-work completed prior to impairing the fire protection? This includes having all piping laid out for new underground; ensure all piping and sprinklers needed for a job is on site and available, etc., and that all piping/connections/equipment be installed/completed to the extent possible before impairing the protection system. If not, can any planned work be completed on a priority basis so that the amount of time of impaired fire protection is minimized?

5. Ensure that the work being done will be carried out without interruption until completion.

6. Can temporary protection be provided by using fire hoses to the sprinkler system and/or fire hydrant? Ensure there are charged small hoses and fire extinguishers available in the area that is impaired.

7. If at all possible, schedule any impairment work be done during idle hours when fewer ignition sources are present.

8. Contact (either by telephone, fax or e-mail), the FM Global Customer Service Desk to inform them of fire protection impairments. Explain the impairment in detail, and depending upon what type of fire protection is impaired, the following information should be provided:

   a) What type of system is being impaired (i.e., sprinklers, halon, CO2, Inergen, AFFF, Fire Pumps, Gravity Tanks/Reservoirs, etc.).

   b) If a sprinkler control valve is closed, provide the following information: What valve is being closed, what area does this fire protection valve protect, the reason why it is being shut, and approximately how long will this system be impaired. If the fire protection will be impaired for some time, look into capping off the affected area and reopening the sprinkler control valve so at least partial protection can be restored to service. Also, look into tying the impaired sprinkler system into a ''live" adjacent system using fire hoses if applicable.

   c) If a fire pump is impaired, provide the following information: Type of fire pump (diesel or electric), is there another fire pump provided that will remain in service; is there still city water pressure available with the pump impaired; the reason why it is out of service; can the pump be started manually in an emergency and if so, will there be someone on site 24 hr./7days per week that knows how to start this pump in an emergency; and the expected duration of this impairment.

   d) If special protection (i.e., Halon, CO2, Inergen, etc.) is impaired, provide the following information: Type of system that is impaired; what area does this system protect; is there automatic sprinkler protection available and in service; can this system be manually tripped in an emergency situation and if so, would personnel be instructed/allowed to do this; reason why this system is being impaired and an estimated timetable for restoration.

   e) If fire alarms are impaired, provide the following information: Is automatic sprinkler protection still in service; is special protection (i.e., halon, CO2, Inergen, etc.) impaired when these fire alarms are impaired; if only fire alarms are impaired, ensure there are key personnel assigned to the duty of calling the public fire service in an emergency; the reason why the alarms are impaired and the expected duration of this impairment.

   f) If a gravity tank, reservoir, etc., is impaired, provide the following information: Is this the only water supply available for fire protection. If so, is there a way to obtain water from other sources nearby (i.e., river, lake, etc.). Could the public fire service park a pumper truck at the facility while they water supply is impaired?

9. Contact the public fire service and inform them of the impaired fire protection.

10. Provide ongoing fire watch patrols of the unprotected area(s).

11. Have someone assigned to respond or stand by the closed valve so it can be opened immediately in an emergency situation. This is also true of an impaired fire pump that can still be manually started.

Once the above has been provided/obtained, discuss the following:

Obtain and properly fill out the Red Tag Permit. Give Parts 2 and 3 of the permit to the person assigned to close the sprinkler control valve and ensure they count the number of turns it took to close this valve. This is done so that when facility personnel are reopening this valve (when work is completed), that they ensure the valve is completely reopened the same number of turns it took to close. The tag should then be attached to the ''closed" valve so that anyone walking by will see and know that the fire protection is impaired. DO NOT LOCK ANY CLOSED SPRINKLER CONTROL VALVES. They should only be locked after they have been fully reopened and fire protection restored to service.

Part 1 of the tag should be kept by the person responsible or the person who authorized the impairment, so that they in turn can confirm, and ensure, that all valves have been fully reopened, when the fire protection is restored to service.

Once work has been completed, do the following:

1. After completion and restoration of fire protection equipment; pertaining to the restoration of automatic sprinkler protection, perform a 2 in. drain test on the downstream side of each valve that was closed. This test is very important as the final check to ensure that all control valves have been left in the wide-open position.

   To do this test, fully open the drain valve and observe the pressure gauge. A quick return of pressure after the drain valve is closed indicates the valve is open to allow good flow. A slow return means there is a partial obstruction. No return means the valve is either totally shut or completely obstructed. Investigate immediately if drain tests are unsatisfactory.

2. If work was being done to install new underground mains, the new mains should be hydrostatically tested at 200 psi for 2 hr. (or 50 psi greater than the working pressure of the system). This will ensure there are no leaks in the underground main. Furthermore, any time either a new underground main is installed or an existing underground main has been repaired, full flushing of the underground is recommended to ensure there are no rocks or other obstructions in the mains.

3. Ensure the fire pump(s) are in full automatic operation.

4. Ensure all sprinkler control valves are locked in the wide-open position.

5. Ensure that all control actuators are replaced and that all control panels/alarm systems are placed back in full service.

6. Contact FM Global's Customer Service Desk and inform them that the impairment is completed and all fire protection has been restored to service.

3.1.2 Valve Locking Methods

Typical recommended valve locking methods are shown in Figures 1 through 9. Do not lock multiple valves together so that unlocking one valve for an authorized operation leaves an adjacent valve unlocked.

Modify older post indicator valves without a locking staple so that they can be locked open. In such cases, an eyebolt may be brazed to the post. Ensure that there is not enough play for the wrench to be lifted vertically to clear the nut on top of the post while the wrench is locked to the locking staple.

Fig.1. Post indicator valve

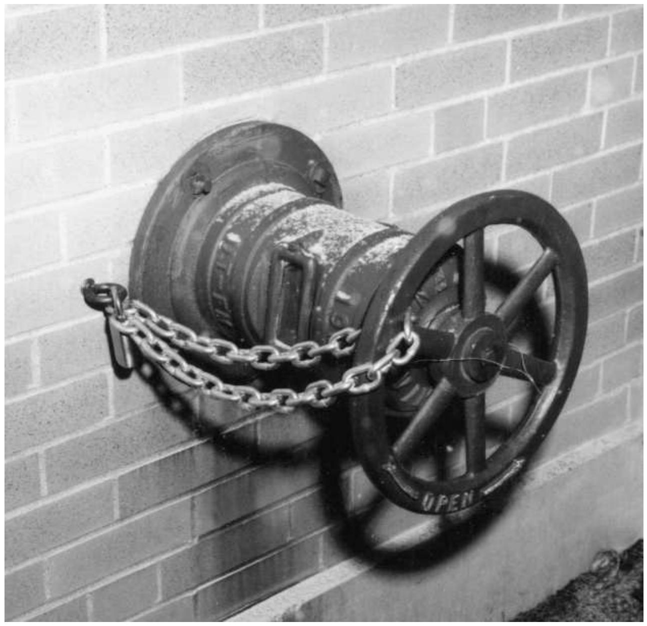


Fig. 2. Wall post indicator valve

Where valve has no loop on the side, install an eyebolt on the wall as shown.

Fig. 3. Wall post indicator valve with handwheel eye bolt.

To lock, loop the chain is through the loop on the side, a spoke of the handwheel and through the hole in the eyebolt. Do not pass the chain only through the eyebolt or only through eyebolt and handwheel.

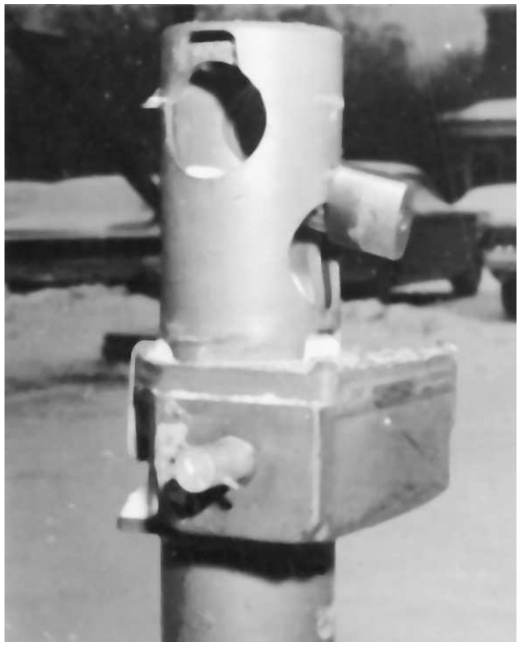


Fig. 4. Post indicator valve assembly (PIVA)

If not provided, drill a hole adjacent to one of the large indicating holes and insert a padlock as shown.

Fig. 5. Indicating butterfly valve (IBV).

Wrap a chain around the base of the valve and the handle, sufficiently tight so that the handle cannot be removed.

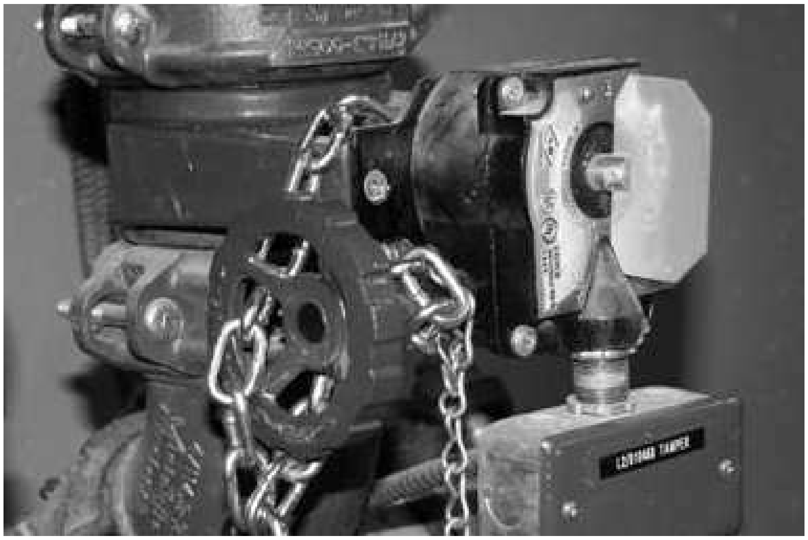


Fig. 6. Indicating butterfly valve (IBV) with handwheel.

Thread a chain through the handwheel and yoke. For a small valve, a cable rather than a chain may be used.

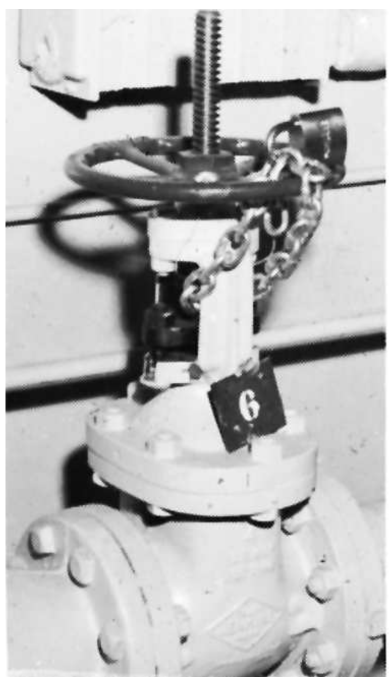


Fig. 7. Outside screw and yoke valve (OS&Y).

Thread a chain through the handwheel and yoke. For a small valve, a cable rather than a chain may be used.

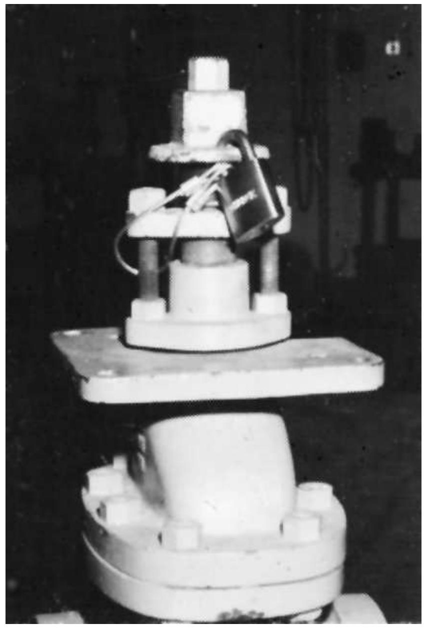


Fig. 8. Inside screw gate valves.

For a large or small valve with a handwheel, thread a chain or cable through the wheel and around the pipe or other anchor loop. Make the chain or cable tight if the handwheel is removable. For large valves without handwheels, the cable or chain may be anchored to lock through a hole in the operating nut.

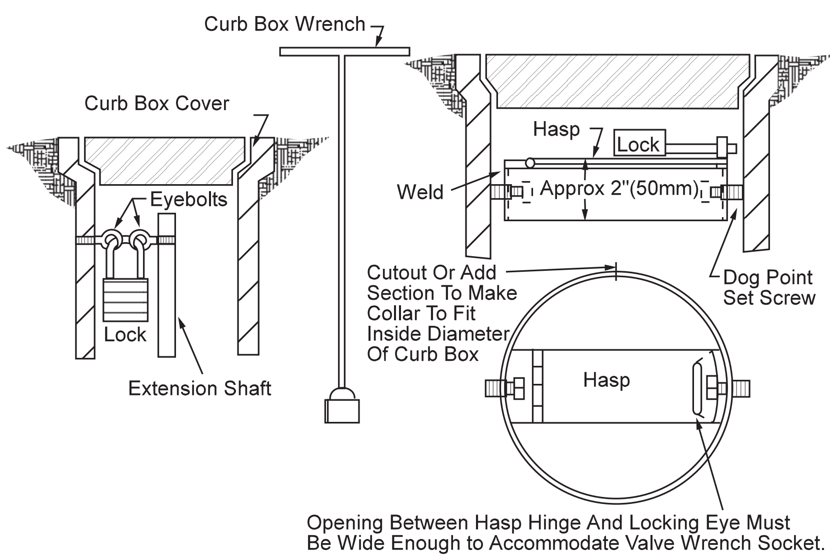


Fig. 9. Curb box valve.

Two methods of locking. For the locking method shown above, there must be an extension shaft in the curb box. A special wrench (center) is required to operate curb box valves. These valves may be sealed by threading the wire through a hole or eyebolt in the extension shaft and through an eyebolt tapped into the housing.

3.1.3 Valve Inspections

Physical Valve Inspection

Physically inspecting a valve includes: 1) unlocking the valve; 2) turning the handwheel or wrench in the full open position direction; 3) turning in the closed direction three turns to ensure operable condition; 4) then a return to the full open position; 5) backing off approximately one-quarter turn to relieve the strain; and 6) relocking the valve. If electronic valve supervision is provided, make arrangements to verify the tamper is operating properly during the monthly physical inspection. Ensure that tamper switches operate when the valve is turned down a maximum of three turns.

In testing indicator posts, the ''spring'' or torsion of the rod will be felt when an attempt is made to turn it beyond the wide open position.

Post indicator valve assemblies (PIVA), indicating butterfly valves (IBV), and outside screw and yoke (OS&Y) valves have fail-safe open position indicators so they need to be physically tried only if there is doubt of their operable condition. Visual inspections are still necessary.

At least once a year, operate all sprinkler control valves the full travel of their mechanisms to make sure they can be operated easily when necessary.

Maintain a record of the number of turns required to operate each valve from the full-open to full-shut positions. This is valuable in determining whether a valve has ''stuck'' partially open.

After valves have been operated, relock them in the wide open position and perform a drain test. (See Section 2.3.9, Main Drain Testing)

Valve Inspection Form

The valve inspection form is the basic guide for the person who makes each inspection. Ensure the form is complete and designed for the particular facility. It is essential that the inspector carry the form, and use it as a checklist, fill it in as rounds are made, not from memory after the inspection is completed. This procedure encourages thorough, conscientious inspections and avoids errors and omissions.

At small facilities (one or two risers), the valve inspection form may be a tag attached to the valve or a placard on the wall near the valve.

A good valve inspection form has the number of and lists each fire system control valve requiring inspection. Indicate the valve location and the area each valve controls, and provide space for recording whether the valve is open, shut, locked or sealed. Provide space on the form for signatures of the valve inspector and the facility manager responsible for taking action to correct any deficiencies.

Valve Marking and Identification

Number the fire system control valves for identification and inspection purposes, and provide a sign indicating the sprinkler/fire protection systems or water supplies they control.

Clearly mark the valves with the direction to open. If not marked by the valve manufacturer, paint the direction of opening on the valve, or on a nearby sign. For underground valves, the marking may be painted on the roadway box or on the sign describing what the valve controls. Post signs indicating distance and direction to curb box valves for locating under ice and snow.

Valve Accessibility

Keep fire system control valves accessible at all times for inspections and emergency situations. Keep valve pits free of water and do not allow ice and snow to accumulate on the pit covers or curb boxes. Where valves or riser drains may be blocked by storage, erect guard rails or paint lines on the floor or pavement to promote clear access. Install permanent ladders where valves are located out of reach.

Supervision of Valves

Central station supervision of valves is of definite value, but it is not an acceptable substitute for regular valve inspections. The contracted supervision may malfunction due to a component failure, improper positioning of detection switches, failure to reset transmitters or failure of communication lines. In addition, the equipment may be taken out of service due to an impairment or for repairs. Since the follow-up by the central office to the original valve closing may not be effective, a valve could remain closed and undetected.

Common Valve Problem Troubleshooting

Common valve troubles requiring immediate attention are as follows:

1. Indicator posts may become inoperative from corrosion or freezing due to a leaking valve. They also may be broken from frost action or from being struck by vehicles.

2. Indicator post targets may be improperly adjusted and prevent full valve travel. Targets also may be accidentally adjusted to read OPEN when valves are closed.

3. Directional arrows on indicator post heads may have two points or may have the wrong point chiseled off.

4. Valve gates can become separated from the operating stems by corrosion or by excessive strain when forced in either direction against obstruction, heavy deposits or friction.

3.1.4 Dry-Pipe Systems

3.1.4.1 Dry-pipe Sprinkler System Maintenance.

General

Dry-pipe sprinkler systems inherently require significantly higher levels of maintenance than wet pipe sprinkler systems due to the increased mechanical complexity, plugging or pipe damage from internal ice formation, and accelerated corrosion rates.

Air Supply

Air for dry-pipe systems may be supplied from individual compressors or from facility air systems. Locate air intakes to compressors where the atmosphere is as cold and dry as practical, avoiding warm, damp areas. Moisture introduced into dry system piping condenses and collects at low points where it may freeze. If air must be taken from a warm area, provide air dryers on the air supply to the dry-pipe systems or use a dry inert gas such as nitrogen. The use of inert gas can slow corrosion attack of the system internal surfaces.

Air Pressure

Unless otherwise specified by the dry-pipe valve manufacturer, maintain the air pressure within the system at approximately 20 psi (140 kPa, 1.4 bar) greater than the trip pressure of the dry-pipe valve based on the highest normal system water pressure. Ensure that air pressure never exceeds system water pressure.

Extremely high air pressure will delay the tripping of the valve. Too low air pressure may cause accidental tripping of the valve when fire pumps are started or pressure surges occur.

Trip Points

The trip point of a differential dry-pipe valve is usually about one-sixth of the water pressure. Trip points of mechanical dry-pipe valves are more or less independent of water pressure, ranging from 5 to 30 psi (35 to 200 kPa, 0.35 to 2 bar).

Trip Time

Ensure that the valve trips and water flows from the remote test connection within 60 seconds or less after opening the test connection. Times greater than 60 seconds may be as a result of system obstructions, valve mechanical problems, or improper installation. If the system is free of obstructions and the valve is functioning properly, accessory accelerators and exhausters can be employed to reduce the time required to trip the valve and exhaust the air in the piping.

Air Leak Testing

Dry-pipe systems, when pressurized with air to 40 psi (280 kPa, 2.8 bar), should not lose more than 1-½ psi (10 kPa, 0.1 bar) over a 24-hour period. Repair systems with excessive leakage.

Abnormal leakage of air may sometimes be found by filling the system with water by tripping the dry pipe valve. If there is danger of freezing, the system may be placed under approximately 50 psi (350 kPa 3.5 bar) air pressure and leaks located by painting joints with a glycerin and soap solution or by introducing oil of wintergreen at the compressor discharge and noting any odor along the piping.

3.1.4.2 Dry-Pipe System Inspections and Tests

To ensure maximum reliability, regularly inspect and test dry-pipe systems as part of a comprehensive fire protection inspection and maintenance program (See Section 2.3.4).

Number and list each dry-pipe valve on the inspection form. Provide spaces for recording: a) air and water pressure; b) adequacy of temperature inside any dry-pipe valve enclosure; and c) condition of quick-tripping devices, if any.

Weekly Inspection
(Daily inspections may be advisable during severe cold weather.)

1. System Pressure. Check and record dry-pipe system air and water pressure.

2. Accelerators and Exhausters. Inspect the quick-opening device condition if provided. Inspect quick-opening devices to make certain that (a) supply valves are open; (b) air pressure and system pressure are equalized; and (c) excess water is drained off.

3. Riser Temperature. Check the temperature in the dry-pipe valve room during winter months. Maintain temperature at or above 40°F (5°C). Heat tape and steam tracing are not satisfactory substitutes for a heated room or enclosure.

Monthly Inspections and Tests

1. Automatic Drain. Make sure the automatic drain from the dry-pipe valve intermediate chamber is free to move. With some valves, this requires lifting the rod that extends through the drain-valve opening, or insertion of a rod or pencil through the valve opening if the drain valve is not so equipped. Where the velocity-type of automatic drain valve is used, make sure by means of the push rod or by feeling through the discharge end of the valve with a finger that the clapper or ball is off its seat.

2. Priming Water. Priming water must be retained over the air clapper to prevent air leakage and premature tripping of the valve. To test for priming water level, use the valve provided for that purpose. However, all dry-pipe valves are not trimmed in the same manner, and it may be necessary to use the priming water supply connection. Draw off excess water, which could prevent the dry-pipe valve from tripping.

3. Air Leakage. Make sure no air leakage has been caused by operation of test valves. Such leakage can be detected by applying water or preferably soap solution to the valve stem at the packing nut. Check for leakage at valves in the air supply line; loss of air here also can cause premature tripping. Stop the leakage at valves by tightening the stuffing boxes.

4. Accelerators and Exhausters. Check the operation of exhausters and accelerators (quick opening devices) when the design permits testing without tripping the dry-pipe valves. Post and follow test procedures based on the manufacturer's recommendations. A sudden drop in air pressure will actuate these devices and trip the dry-pipe valves. When it is necessary to reduce system air pressure, shut off or deactivate the quick opening device. After completing work, be certain the equipment is left in operating condition.

5. Low Point Drains. Just prior to and during freezing weather, test all low points by opening the drain valve to see that pipes are entirely free of water or ice. Depending on the amount of condensate in the piping, more frequent inspecting and draining may be necessary.

Quarterly Inspections and Tests

1. Alarms. Test alarms by admitting water through the test connections to the pressure switches and/or water motors. Test hydraulic alarms only when pipes and water motors are not subject to freezing. In prolonged cold spells see that moving parts are free and the pipes drained and clear of frost.

Annual Inspections and Tests

1. Trip Test. Annual trip testing of dry-pipe valves is recommended to ensure reliable operation. Record trip test records and compare with previous test results. Record details of the trip test such as static water pressure, system air pressure, and trip point air pressure and valve trip time after test valve air release. Testing is the best means of determining whether adjustments, repairs, or replacement of parts are needed. Valves that have not been operated for several years may fail or be very slow in action. Delayed tripping of a dry-pipe valve in event of fire could be disastrous.

Make annual trip tests during the season when there is no danger of freezing. Also, if possible, make trip tests when facility operations are shut down in the area controlled. If more than one valve can be worked on at a time, select alternate systems to avoid impairments to large areas where protection cannot be restored quickly. Before control valves are closed, follow the fire protection impairment precautions outlined in Section 3.1.1.

Before the tests, see that controlling valves are open, and make the usual flow test from the 2 in. (50 mm) drain. If there is evidence of foreign material in the yard mains, flush them clean before the starting other tests.

Examine automatic drip valves at the dry-pipe valve to make sure they are open, not obstructed with scale or dirt, and operative so far as can be determined. Ball drips may be taken apart for this inspection. Where there is central-station sprinkler supervisory service or flow alarms connected to the public fire service, make arrangements to avoid calling out fire apparatus or messengers.

Release the air through the system test valve at the end of the sprinkler system in order to simulate the operation of one sprinkler. Install a system test valve if one is not provided.

To prevent water from entering the sprinkler system, throttle the control valve to a position where flow from a 2 in. (50 mm) drain would maintain about 5 psi (30 kPa, 0.3 bar) under the dry-pipe valve. Immediately after the dry-pipe valve trips, close the control valve and open the drain valve. By keeping as much water as possible out of the piping, drainage is made easier, especially if there are many low points or pendent sprinklers.

Tripping dry-pipe valves with throttled water supplies will not completely operate some models that require a high rate of flow to complete the movements of the parts. In that case, a higher flow rate may be needed to ascertain that all parts are free to move and the valve trips properly.

After the test, thoroughly drain the system including low point drains and remove the cover plate from the valve. Examine the position of the parts, and determine whether or not operation has been normal. Thoroughly wash the inside of the body, and wipe the clappers dry with a clean cloth. Remove all dirt and scale, giving special attention to the small valves or ports to drains and alarm devices. Examine particularly for dirt under the clapper hinges; a large amount of dirt may indicate the system is obstructed.

If rubber rings or seats are deformed or otherwise in poor condition, replace them with new parts supplied by the valve manufacturer. Keep spare rubber on hand for quick replacement to avoid an extended impairment.

2. Pitch of Pipes. Dry systems may freeze-up as a of water collecting in improperly pitched pipes. Carefully check the pitch of all piping in dry-pipe systems each autumn, using a spirit level to detect dips and small pockets in the lines. Sagging floors and roofs may seriously interfere with drainage even if the pipes were properly pitched when installed. Replace broken, missing, or loose hangers, and otherwise restore the system to ensure good drainage. Install valved drains at all low points that cannot be eliminated.

3.1.5 Fire Protection System Obstructions

3.1.5.1 Obstruction Sources

(1) Pipe Scale

Dry-pipe sprinkler systems are involved in the majority of obstructed sprinkler systems. 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 there are 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.

(2) 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 are some materials that have been found as obstructions. In some instances, with welded sprinkler systems and systems with cut holes for quick connect fittings, the cutout disks or coupons have been left inside the piping, obstructing flow to sprinklers.

(3) 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 also are common. These materials can obstruct piping as well as accumulate in the orifices of pendent sprinklers.

(4) 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 from approximately ⅜ to 7⁄16 in. (9 to 11 mm) across the shell in one year and to 2 in. (50 mm) or 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 attach themselves to the pipes and feed on bacteria or algae that pass by.

Originally brought to the United States from Asia in the 1930s, the clams have spread throughout much of North America. 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).

Similarly the Zebra mussel *(Dreissena polymorpha)* are small, fingernail-sized mussels in the Great Lakes Region of the United States and Canada and are known to attach and grow within sprinkler system suction piping. As the mussels only grow in near-stagnant water, they are found only in lakes, ponds, and very low-flow velocity rivers.

Microbiologically influenced corrosion (MIC) is a source of internal pipe corrosion and pipe leakage. Data Sheet 2-1, *Corrosion in Automatic Sprinkler Systems*, covers the topic in detail.

(5) Sprinkler Calcium Carbonate Deposits

Natural fresh water contains dissolved calcium and magnesium salts in varying concentrations, depending on source 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 areas shown in white in Fig. 10 (Great Lakes water is only moderately hard).

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

- In wet systems only.

- In high temperature areas, except where water has unusually high pH. (See Fig. 11) High temperature areas include around dryers, ovens, near skylights or at roof peaks.

- In old sprinkler systems, which are frequently drained and refilled.

- In pendent sprinklers that are away from air pockets and near convection currents.

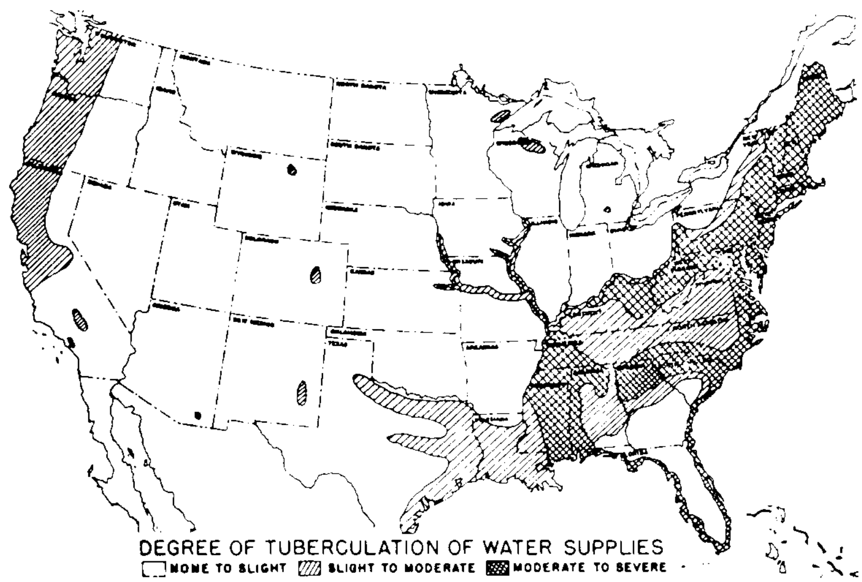


Fig. 10. Degree of tuberculation of water supplies in the United States. (Courtesy Cast Iron Pipe Research Association)

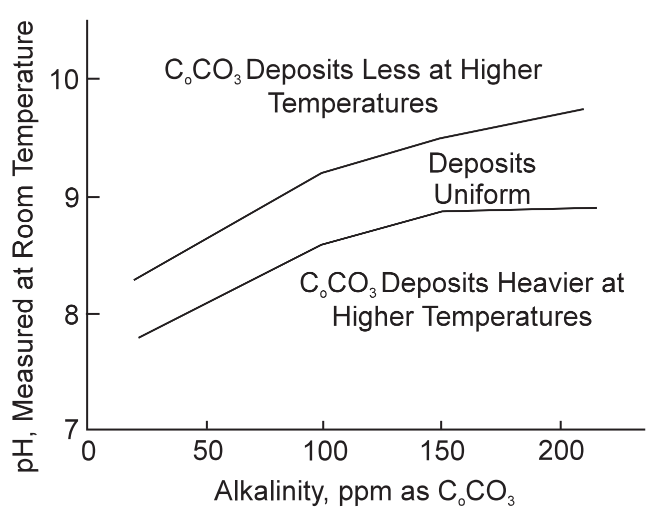


Fig. 11. Scale deposition, as a function of the alkalinity -pH ratio.

3.1.5.2 Obstruction Prevention Program

1. Frequencies and Conditions for a Flushing Investigation. Follow the frequency and condition guidelines contained in section 2.6 of this data sheet.
2. Flushing Connections. Ensure all sprinkler systems are arranged to facilitate flushing. Provide flushing connections at the end of each cross main. Arrange branch lines on gridded systems to be capable of being readily ''broken'' at a simple union or flexible joint. (See Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*)
3. Drain Tests. For newly installed sprinkler systems, conduct a drain test and flow water through the Inspector's Test Connection to verify that control valves have been left wide open and flange blanks removed.
4. Welding Coupons. Visually confirm prior to system acceptance that all cutouts (coupons) have been removed in welded sprinkler systems and systems with pipe with holes cut into it for the installation of quick-connect fittings. (See Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*)
5. Sprinkler Return Bends. Provide return bends for pendent sprinklers when water supply is from an open body of water.
6. Underground Mains. Take care when installing underground mains, both public and private, to prevent entrance of stones, soil or other foreign material. As a condition of acceptance, require installers to flush all newly installed mains before connecting to inside piping to ensure foreign material does not enter the system. Flush yard mains after repairs or when breaks have occurred in public mains.
7. Fire Pump Suction Supplies.

   (a) Screen pump suction supplies and maintain the 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 tanks 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.
8. 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. It has been discovered that under laboratory conditions, 100% larvae mortality may be achieved after 96 to 108 hour exposure to 0.4 ppm chlorine. Such conditions may be difficult to achieve in fire protection systems.
9. Zebra Mussels. Chlorine and hot water exposure has been shown to kill both larval stage and adult stage mussels. However, whether alive or dead, physically scraping the adult stage mussels from an infested pipe interior surface is required in order to clear the pipe.
10. Calcium Carbonate Deposits. For localities suspected of having hard water, remove and inspect sample sprinklers annually. Figure 10 outlines sprinkler locations prone to having deposits when hard water is a problem. Replace sprinklers found with deposits and check adjacent sprinklers.

3.1.5.3 Obstruction Investigation Procedure

Conduct investigations 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. Inspect suction tanks internally. Determine whether loose scale is on the interior 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, FOLLOW THE FIRE PROTECTION IMPAIRMENT PRECAUTIONS OUTLINED IN SECTION 3.1.1. 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.

(1) Investigating Yard Mains

Flow through yard hydrants, preferably near the extremes of selected mains, to determine whether mains contain obstructive material. Preferably, connect two lengths of 2-½ in. (64 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 the condition of the main being investigated. If there are several sources of water supply, investigate each independently, avoiding any unnecessary interruptions to sprinkler protection. On extensive yard layouts, repeat the tests at several locations, if necessary, to determine general conditions.

If obstructive material is found, thoroughly flush all mains before investigating sprinkler systems. (See Section 3.1.5.4, Flushing Procedure)

(2) Investigating Sprinkler Systems

Investigate dry systems first. Tests on several carefully selected, representative systems usually are sufficient to indicate general conditions throughout the facility. 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 crossmains; 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 determining whether the system is unobstructed. Obstruction potential is based on the physical characteristics and source of the foreign material.

Applying guidelines for determining whether the system is free from obstructing material is often a judgment based on the actual physical evidence obtained. Base the analysis on whether there appears to be sufficient material of sufficient size that could obstruct the flow of water through smaller branch lines and sprinklers.

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.

Include test flows through 2-½ in. (64 mm) fire hose directly from cross mains (Figs. 12 and 13) and flows through 1-½ in. (38 mm) hose from representative branch lines. Two or three branch lines per system is considered a representative number of branch lines when investigating for scale accumulation. If significant scale is found, investigate additional branch lines. 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.

If the facility has a fire pump, ensure that it is in operation for all flows. Use burlap bags or equivalent to collect dislodged material as is done in the investigation of yard mains. Continue each flow until the water clears. Allow a minimum of 2 to 3 minutes at full flow for sprinkler mains.

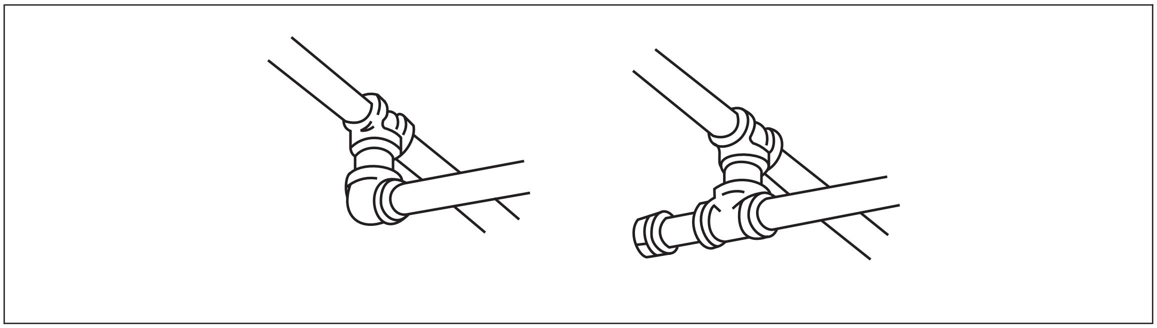


Fig. 12. Replacement of elbow at end of cross main with a flushing connection consisting of a 2 in. (50 mm) nipple and cap.

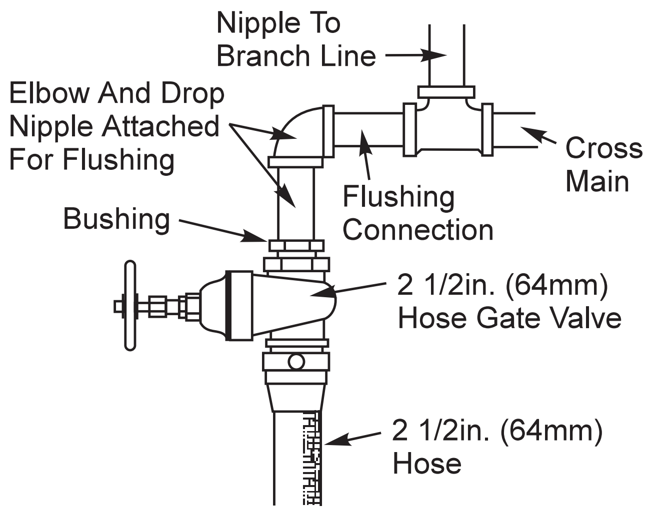


Fig. 13. Connection of a 2-½ in. (64 mm) hose gate valve with 2 in. (50mm) bushing and nipple and elbow to 2 in. (50 mm) cross main.

(a) 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 release air from the system. Check the piping visually with a flashlight while it is being dismantled. Attach hose valves and 1-½ 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. Clear any obstructions 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 2-½ in. (64 mm) fire hose, collecting any foreign material in a burlap bag.

After the test, internally clean and reset the dry-pipe valve. Lock its control valve open and conduct a drain test.

(b) Wet Pipe Systems

Testing wet systems is similar to testing dry systems except the system must be drained after closing the control valve to permit the 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 2-½ 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 facility, keeping a detailed record of what is done.

(c) Other Obstruction Investigation Methods

Other obstruction investigation methods, such as videoscope, boroscope, ultrasonic and X-ray examination, have been evaluated. Although these methods may be successful at detecting obstructions, they tend to be time-consuming and require direct access to sprinkler piping. For most situations, some are presently no more economical or practical than the conventional flushing investigation method. The one exception is that use of videoscopic techniques can, when used properly, indicate the need for full flushing without having to do a complete flushing investigation.

3.1.5.4 Flushing Procedure

If investigation indicates the presence of sufficient material to obstruct sprinklers, conduct a complete system flushing program. The work may be done either by qualified sprinkler contractors or by competent facility personnel. Determine the sources of the obstructing material and take steps 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, request waterworks authorities to flush their system.

(1) Yard Mains

Thoroughly flush yard mains before flushing any interior piping. With new installations, conduct flushing before connecting to sprinkler systems. 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/s (3 m/s) is necessary for scouring the pipe and for lifting foreign material to an aboveground flushing outlet. Use the flow specified in Table 9 or the maximum flow available for the size of the yard main being flushed.

Table 9. Waterflow Recommended for Flushing Piping

Size of pipe		**Flow**		**Size of pipe**		**Flow**	
in.	**(mm)**	**gpm**	**(l/min)**	**in.**	**(mm)**	**gpm**	**(l/min)**
¾	(19)	17	(65)	3-½	(89)	300	(1,135)
1	(25)	27	(100)	4	(100)	390	(1,475)
1-¼	(32)	47	(180)	5	(125)	620	(2,345)
1-½	(38)	63	(240)	6	(150)	880	(3,325)
2	(50)	105	(395)	8	(200)	1,560	(5,895)
2-½	(64)	149	(565)	10	(250)	2,440	(9,225)
3	(76)	220	(830)	12	(300)	3,520	(13,305)

Flush connections from yard piping to sprinkler risers. These are typically 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. (150 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 presence of large size material is suspected, a larger outlet will be needed to pass such material and to create the 750 gpm (2839 l/min) flow necessary to move it. Fire service connections on sprinkler risers can be used as flushing outlets by removing or inverting the check valve. Yard mains also can be flushed through a temporary fitting installed on the riser connection before the sprinkler system is installed. (Fig. 14).

(2) 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 l) 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 facility. 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.

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.

Flood dry-pipe systems with water one or two days before a flushing to soften pipe scale and deposits.

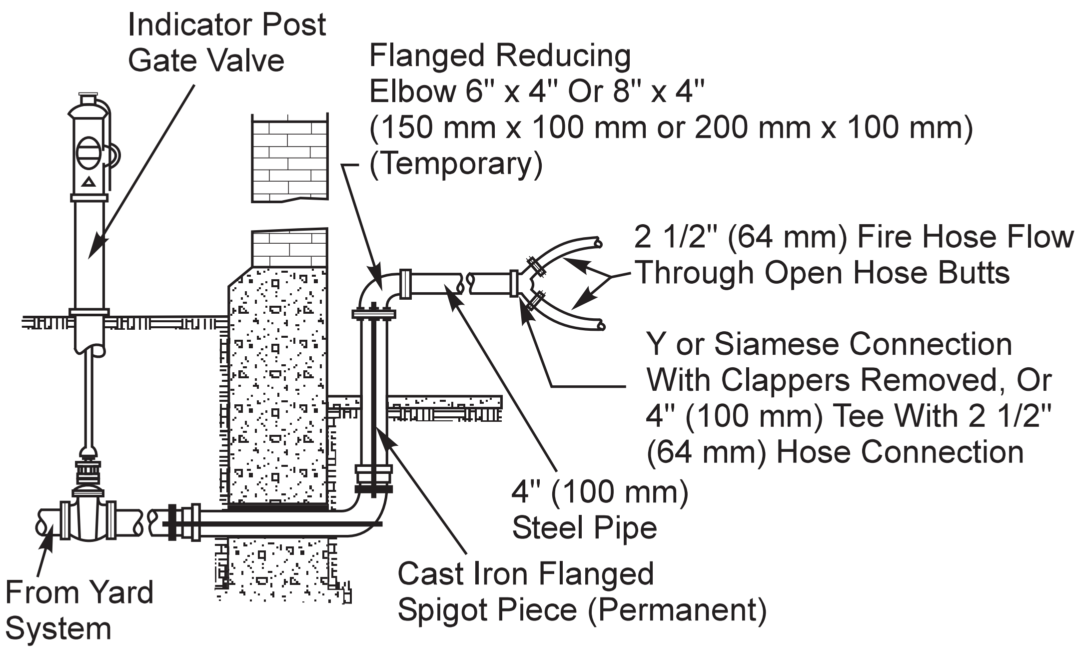


Fig. 14. Arrangement for flushing of sprinkler riser underground lead-in piping (New Installation).

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 hydropneumatic method, this is accomplished by the air pressure behind the charge of water. With the hydraulic method, ensure water flow rates are at least the rates of flow indicated in Table 7.

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 the hose to a larger section, if necessary.

Where pipe scale indicates internal or external corrosion, clean and measure the pipe wall thickness to determine if the walls of the pipe have weakened. Hydrostatically test the system as outlined in Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*.

Remove several sample pendent sprinklers per system and inspect until it can be concluded that all sprinklers 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.

(a) Hydraulic Method

After the yard mains have been thoroughly cleared, flush risers, feed mains, cross mains and finally the branch lines. In multi-story buildings, flush systems by starting at the lowest story and working up. Branch line flushing in any story may follow immediately 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 2-½ in. (64 mm) hose gate valves to the extreme ends of these lines (Fig. 13). Such valves usually can be procured from the manifold of fire pumps or hose standpipes.

As an alternative, an adapter with 2-½ in. (64 mm) hose thread and standard pipe thread can be used with a regular gate valve. Attach a length of fire hose without a nozzle to the flushing connection. To prevent kinking of the hose and to obtain maximum flow, install an elbow 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. Use a minimum 1-½ in. (38 mm) hose diameter and keep it as short as practical. Branch lines may be flushed in any order that will expedite the work.

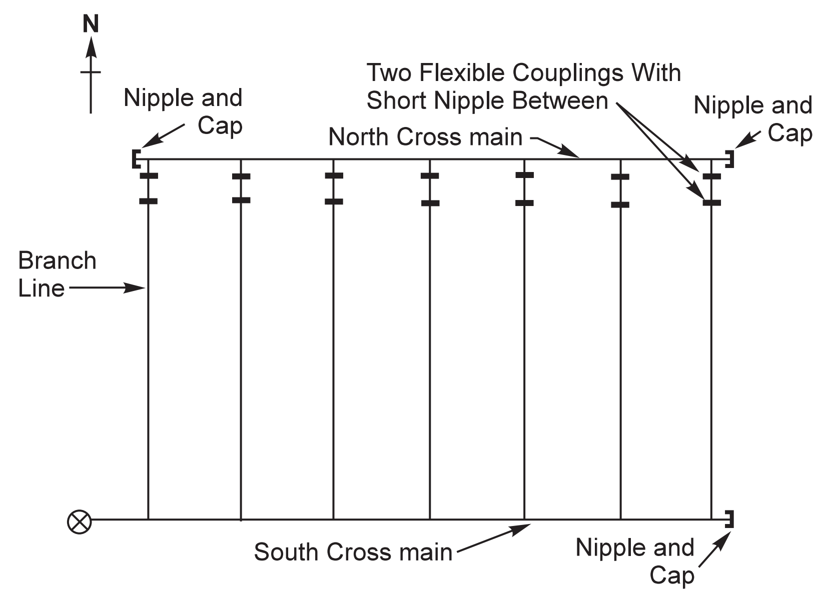


Fig. 15. A typical gridded piping arrangement prior to flushing.

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.

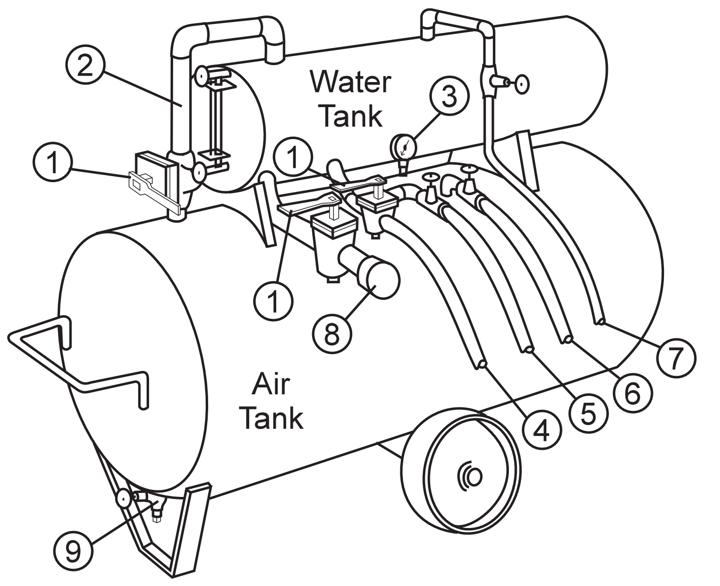
5. Reconnect enough branch lines at the west end of the system so the aggregate cross-sectional area of the branch lines approximately equals the area of the north cross main. For example, three 1-¼ in. (32 mm) branch lines approximately equal a 2-½ in. (64 mm) cross main. Remove the cap from the east end of the north cross main, flush the main and replace the cap.

6. Disconnect and recap the branch lines. Repeat Step 5 except reconnect branch lines at the east end of the system and flush the north cross main through its west end.

7. Reconnect all branch lines and recap the cross main. Verify the sprinkler control valve is left in the open and locked position.

(b) Hydro-pneumatic Method

The apparatus used for hydropneumatic flushing consists of a hydropneumatic machine, a source of water, a source of compressed air, a 1 in. (25 mm) rubber hose, for connecting to branch lines and a 2-½ in. (64 mm) hose for connecting to cross mains.



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. (25mm) 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. 2-1/2 in. (64mm) pipe connection. When flushing large interior piping, connect woven jacket fire hose here and close plug cock 1 in. (25mm) hose connections (4) used for flushing sprinkler branch lines.
9. Air tank drain valve.

Fig. 16. Hydropneumatic machine.

The hydropneumatic machine (Fig. 16) consists of a 30 gal (114 l) water tank mounted over a 25 ft^3 (700 L) 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 a hose to a suitable water supply. The compressed air tank is connected through a suitable air hose to either the facility air system or a separate air compressor.

To flush the sprinkler piping, the water tank is filled with water, the pressure raised to 100 psi (690 kPa, 6.9 bar) in the compressed air tank, and the plug cock between tanks opened to put air pressure on the water. The water tank is connected by a hose to the sprinkler pipe to be flushed. Then the lubricated plug cock on the discharge outlet at the bottom of the water tank in 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 2-½ in. (64 mm) hose lines or for discharge into a drum. (Maximum capacity per blow is about 30 gal [114 l]). If the 2 in. (50 mm) riser drain is to be used, remove the drain valve and make a direct hose connection. 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, do not use the hydro-pneumatic method.

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 the piping is clear after it has been flushed. Investigate representative branch lines and cross mains using both visual examination and sample flushings.

1. Branch Lines

With the yard mains already flushed or known to be clear, flush the sprinkler branch lines 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. (Fig. 17) 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.

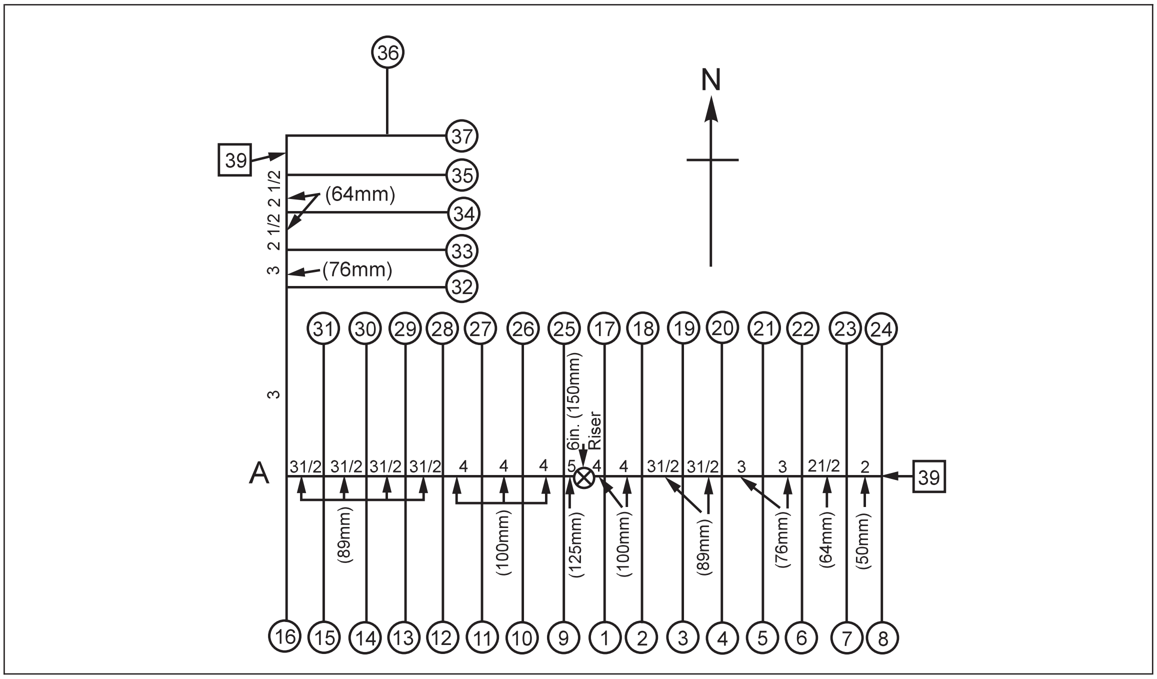


Fig. 17. Schematic diagram of a sprinkler system, showing the sequence to be followed when the hydro-pneumatic method is used.

Air hose, 1 in. (25 mm) in diameter, is used to connect the machine with the end of the branch line being flushed. The hose should be as short as practical. When the blow is made, allow the air pressure to drop to 85 psi (586 kPa) (5.9 bar) 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 l) 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 bar). Connect the machine to the end of the cross main to be flushed with not more than 50 ft (15.2 m) of 2-½ 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 Fig. 17, 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 the water will pass through a minimum number of right-angle bends. In Figure 17, blows at 38 would 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 32 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, make the connection directly to the cross main corresponding to the 3-½ 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 17.

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 Fig. 17) working toward the most remote line. Next flushed in Fig. 17 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 at the other end.

3.1.6 Automatic Sprinklers

3.1.6.1 Overheating

Overheating means subjecting sprinklers to temperatures in excess of the recognized safe maximum temperature in the absence of fire. It may result from hot processes, artificial heat, or lack of ventilation. If the temperature approaches the rated operating temperature even for a short period, it may cause sprinklers to open. If a solder-type sprinkler is exposed for a long time to a high temperature, although below its rated temperature, the soldered joint may gradually give way, with partial separation of the soldered members. This weakness will, in time, cause the sprinkler to operate. Proper temperature ratings for sprinklers are given in Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers.*

Changes in occupancy that may affect room temperatures, such as increased drier temperatures, installation of new heat-producing equipment, overhead heating coils or unit heaters, frequently cause premature opening of sprinklers through overheating. When such changes are made, install sprinklers of higher ratings, if needed.

Nominally rated 360°F (182°C) solder-type sprinklers may fail to open after prolonged exposures to temperatures of approximately 300°F (149°C). The maximum allowable ambient temperature to which 360°F (182°C) sprinklers may be exposed is 300°F (149°C). The suspected cause of failure is the migration of tin from the high tin content solder alloy into the brass of the sprinkler link. Also, some of the brass's copper migrates into the solder. The result is a new, higher melting point alloy at the junction of the solder and brass. Sprinkler manufacturers have altered the design of the link in an attempt to reduce solder migration. It has not yet been determined whether this is an effective solution. Testing is recommended every three years to verify the condition of 360°F (182°C) sprinklers that are exposed to high temperatures.

Bulb-type sprinklers and those using a chemical compound having a sharp melting point do not have the ''cold-flow" properties of solder and are not subject to danger of operation from long exposure to temperatures below that of normal operation. In a very few instances, bulbs of sprinklers manufactured prior to 1931 have developed minute cracks as a result of being repeatedly subjected to temperatures close to the operating point. This allows liquid to escape, making the sprinkler inoperative. Replace the sprinkler if a bulb-type sprinkler is observed with no liquid or less than the normal level of liquid in the bulb.

3.1.6.2 Corrosion

Corrosive atmospheres may build up deposits that prevent sprinklers from opening by attacking the solder so it is chemically changed or becomes hard and infusible.

Typical corrosive atmospheres are produced by chlorine, phosphine, sulfur dioxide, zinc chloride, ammonia, and hydrochloric, sulfuric and acetic acids. Corrosion of unprotected sprinklers can usually be detected by effects varying from an inconspicuous discoloration of the frame and gray powder on the solder, caused by acetic acid fumes, to the brilliant green caused by chlorine fumes.

External appearance is not always a sure guide, and badly corroded sprinklers may appear only slightly discolored. Corrosion, once started, is usually progressive and in time renders the sprinkler completely inoperative. A very thin hard corrosion on a sprinkler that has been in service 15 to 20 years is generally more harmful than a loose bulky deposit on a more recently installed sprinkler, even though the older sprinkler may appear to be in better condition.

All sprinklers are likely to become inoperative when hard deposits form around the valve-retaining members and pack tightly between the arms of the yoke.

3.1.6.3 Corrosion Prevention

FM Approved wax-coated, lead-coated, wax-over-lead coated, and stainless steel sprinklers may be used in corrosive environments. Ensure the selection of sprinklers takes into consideration the corrosive environment and the compatibility with the sprinkler materials.

Care must be taken not to injure the coating during the installation of such sprinklers. If any of the wax is broken off, touch up the bare spots with a brush dipped in warm liquid wax. Bulb-type sprinklers are somewhat less susceptible to corrosion than other types, but metal parts need to be protected by wax.

A lead coating is effective against mild corrosion, but soldered links of lead-coated sprinklers require a wax coating.

See Data Sheet 7-78, *Industrial Exhaust Systems*, for corrosion protection for duct sprinkler systems.

3.1.6.4 Internal Pipe Corrosion

Limited corrosion is always present in water-based fire protection systems. The limiting of internal corrosion to even surface-level oxidation will result in a long service life of system piping and components.

There are several common conditions that can accelerate corrosion in any water based fire protection system. They are:

- Source water corrosivity
- Trapped air (air/water boundary)
- Frequent introduction of oxygen rich water
- Dissimilar metals (galvanic)
- Microbiological (MIC) based corrosion

See FM Global Data Sheet 2-1 *Corrosion in Automatic Sprinkler Systems* for additional guidance.

4.0 REFERENCES

4.1 FM Global

Installation Standards
Data Sheet 2-1, *Corrosion in Automatic Sprinkler Systems*
Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*
Data Sheet 3-2, *Water Tanks for Fire Protection*
Data Sheet 3-7, *Fire Protection Pumps*
Data Sheet 3-10, *Installation and Maintenance of Private Fire Service Mains and Their Appurtenances*
Data Sheet 4-0, *Special Protection Systems*
Data Sheet 4-1N, *Fixed Water Spray Systems for Fire Protection*
Data Sheet 4-2, *Water Mist Fire Protection*
Data Sheet 4-3N, *Medium and High Expansion Foam Systems*
Data Sheet 4-4N, *Standpipe and Hose Systems*
Data Sheet 4-5, *Portable Extinguishers*
Data Sheet 4-7N, *Low Expansion Foam Systems*
Data Sheet 4-8N, *Halon 1301 Extinguishing Systems*
Data Sheet 4-9, *Clean Agent Fire Extinguishing Systems*
Data Sheet 4-10, *Dry Chemical Systems*
Data Sheet 4-11N, *Carbon Dioxide Extinguishing Systems*
Data Sheet 5-40, Fire Alarm Systems

Data Sheet 5-48, *Automatic Fire Detection*
Data Sheet 7-78, *Industrial Exhaust Systems*
Data Sheet 8-29, *Refrigerated Storage*

Reference Material
Data Sheet 2-10R, *Dry-Pipe, Deluge, Preaction Valves and Accessories*
Data Sheet 9-18, *Prevention of Freeze-Ups*
“Pocket Guide to Inspecting, Testing and Maintaining Fire Protection Equipment” (P0418)
“Pocket Guide to Property Inspections”, (P0301)
“Red Tag Permit System” (P9006)
“Hot Work Permit System” (P9311)
“Fire Protection Control Valves”, (P9603)
“Fire Pump Testing and Maintenance Checklist”, (P8217)
“Tripping Record of Dry-Pipe, Deluge, or Pre-action Valves”, (P57)
“Freeze-up Checklist”, (P9521)

4.2 NFPA Standards

Material in this data sheet is covered in part by various NFPA standards, in particular, NFPA 25, *Inspection, Testing and Maintenance of Water-Based Fire Protection Systems*. Generally, FM Global guidelines agree with those of NFPA 25, except that some testing frequencies may differ.

APPENDIX A GLOSSARY OF TERMS

Actuator: The agent release means of a fire protection system.

Approved: References to ‘‘Approved’’ in this data sheet means the product and services have satisfied the criteria for FM Approval. Refer to the Approval Guide, a publication of FM Approvals, for a complete listing of products and services that are FM Approved.

Automatic: An operation that occurs without human intervention.

Fire Service Connection: A connection to the sprinkler system or standpipe through which the fire service can pump supplemental water into the system.

Fire Hydrant: A valved connection on a water main for the purpose of supplying water to fire hose or other fire protection equipment.

Foam Concentrate: A liquid that is stored in a containment vessel that, when metered into a flowing water stream at a specific concentration, will generate a foam/water mixture for fire fighting purposes.

Control Valve: A valve controlling water or agent flow to an automatic fire protection system.

Conventional Sprinkler: A sprinkler deflector design that directs half the discharging water above and half the water below the plane of the sprinkler deflector.

Deluge Valve: A control valve that automatically releases water to a piping system that supplies open nozzles.

Dry Pipe Valve: A control valve that, on loss of system air pressure, automatically releases water into a piping system that supplies closed nozzles.

Dry Pendant Sprinkler: A dry extension to a sprinkler’s waterway that has an inlet seal that operates with the sprinkler fusible element in order to keep water a specified distance from a sprinkler that may be located in a freezing environment.

Flushing: The practice of flowing water or pneumatically blowing through a fire protection piping system for the purpose of removing obstructions.

Hose Connection: A valve and connection method for fire hose.

Impairment: The planned or unplanned shutdown of a fire protection system.

Inspection: A visual examination that determines if a condition, device, equipment, or system is suitable for service.

Main Drain/(2 inch drain): The primary drain for a sprinkler system located on the system riser.

Maintenance: Work conducted to ensure continued satisfactory operation of a device or system.

Obstruction: Foreign material in a fire protection system that restricts or prevents flow.

Open Water Supply: Fire protection water source that is open to an outdoor environment such as open reservoirs, ponds, lakes, rivers.

Pre-action Valve: A control valve that, upon some combination of detection of a fire and loss of system air pressure, automatically releases water into a piping system that supplies closed nozzles.

Pressure Reducing Valve: A valve that will reduce the downstream fire protection water pressure under both flowing and non-flowing conditions.

Scale: Thin surface deposits that develop on the interior of fire protection water pipe due to corrosion.

Supervision: An automatic means of monitoring a system or a device status and indicating abnormal conditions.

Testing: To physically operate a device or system for the purpose of verifying operational condition.

APPENDIX B DOCUMENT REVISION HISTORY

April 2017. Interim revision. Minor editorial changes were made.

April 2012. Terminology related to ignitable liquids has been revised to provide increased clarity and consistency with regard to FM Global's loss prevention recommendations for ignitable liquid hazards.

January 2008. Minor editorial changes were made.

April 2007. Revised recommendation 2.3.9 on main drain testing.

January 2007. The following changes were made:

1. Reorganized and reformatted the entire document.

2. Changed waterflow alarm testing frequency to quarterly from monthly.

3. Removed guidance on non-owned valve inspection frequency.

4. Changed obstruction investigation frequency for black steel pipe on dry systems from 15 years, 25 years and 5 years thereafter, to 10 years, 20 years and 5 years thereafter.

5. Clarified the need for flushing investigations every 5 years for all sprinkler systems fed from open bodies of water.

6. Added annual obstruction investigation requirement for dry and pre-action systems that trip frequently that take suction from open reservoirs.

7. Provided more specific guidance for special hazard protection systems (Table 8).

8. Removed guidance on non-OEM plating of sprinklers.

9. Added internal pipe corrosion guidance.

10. Clarified inspection frequency for hydrant control valves.

11. Clarified the water delivery time requirement of 60 seconds for dry system testing.

12. Added Zebra mussel obstruction information.

January 2006. Minor editorial changes were made for this edition of the data sheet.

September 2005. Minor editorial changes were made for this edition of the data sheet.

January 2003. Minor editorial changes were made for this edition of the data sheet.

January 2001. An FM Global comment has been added after Section 2.10, Condition of Sprinklers, outlining requirements for sprinkler testing contained in NFPA 25, ''Inspection, Testing and Maintenance of Water-based Fire Protection Systems'', and the FM Global position in that regard.

September 2000. This revision of the document has been reorganized to provide a consistent format.

July 1986. The following changes were made in:

1. The section entitled ''Precautions Against Freezing'' has been revised to include recommendations to establish an active cold weather readiness program. Additional cold weather precautions based on loss report recommendations have also been included.

2. The section on sprinkler system obstructions has been revised.

a) A recommendation has been included that all proposed preaction and dry systems should be installed using galvanized piping. Loss studies have shown that dry-pipe systems are involved in the majority of obstructed sprinkler system fire losses. Pipe scale was found to be the most frequent obstructing material.

b) The recommendation to flush dry system no more than 10 years after installation has been revised to 15 years, 25 years and every five years thereafter. Loss studies have better defined those systems most likely to be obstructed and to result in a large loss. The importance of flushing has been emphasized by listing conditions that ''do'' rather than ''may'' indicate the need for flushing.

c) Discussion with regard to Asiatic Clams has been added. Thus far the majority of problems associated with this clam have involved clogging of condensers, heat exchangers, pump impellers and other associated water systems for power utilities and industry. However, there has also been an instance reported to FM Global Research where two dry-pipe sprinkler valves failed to trip during testing due to ''several buckets of clam shells'' found on the wet side of the system. At several other locations, sprinkler piping has been found plugged with shells and clam growth found inside protection mains. To date, no effective method of controlling clam infestations has been established. The problem is still under investigation. It is suspected that chlorination is the most practical method. Should chlorination be used, it is suggested that clams within the fire protection system be exposed to a minimum residual chlorine concentration of 0.2 ppm continually for a minimum three-week period. For control, the treatment should be applied at least for one period in the spring and one period in the fall, the clam's primary spawning periods.

d) A recommendation regarding sprinkler cutouts (coupons) has been included. Originally, the problem became apparent after investigating a fire in a spray booth involving two obstructed sprinklers. About 37 cutouts ranging in size from 1 to 4 in. (2.5 to 10.0 mm) were recovered from the sprinkler piping. They had fallen into the pipe when the hole was cut for the welding operation. At least seven other locations have been discovered with the same problem.

3. The sections on valve and fire safety inspections has been updated to reflect the current recommended practices specified in appropriate Operating Requirements. Locking the ''T'' wrench is an acceptable alternative to locking curb box valves.

4. The section ''Fire Protection Impairment Precautions'' was revised for consistency with the Fire Safety Warning Kit directives. Also, the use of portable pipe freezing equipment to isolate repairs is discouraged because it does not allow prompt restoration of the fire protection system should the need arise.

5. The preferred method of heating a dry-pipe valve is by heating the dry-pipe valve room or enclosure. Use of heat tracing systems are discouraged due to the complexity in proper design, installation and maintenance. In one case, a heat tape thermostat malfunctioned causing the dry-pipe valve to overheat and the clapper facing to stick to the seat.

The July, 1986 revision completely superseded the January 1977 version of Data Sheet 2-81 and the December 1975 version of Data Sheet 2-81C, as well as TLG Memoranda 79-46, 80-9 and 82-6.

APPENDIX C INSPECTION FORMS

TRIPPING RECORD

DRY PIPE VALVES

Use next page for deluge or pre-action valves.
Caution: Do not use grease or pipe compounds on valve seats.
Dry-pipe valves should be tripped, cleaned and reset annually

Instructions: Use one card for each dry-pipe valve. Post securely in dry-pipe valve enclosure.
Record the data each time the valve trips or is tripped.

VALVE MANUFACTURER'S NAME		MODEL NUMBER		YEAR INSTALLED		VALVE NO./AREA CONTROLLED			
DATE TRIPPED	CAUSE OF TRIPPING OR BY WHOM TRIPPED	STATIC WATER PRESSURE	SYSTEM AIR PRESSURE	TRIP POINT AIR PRESSURE	TRIP TIME MIN. – SEC.	DATE RESET	RESET BY	RED TAG PERMITS USED?	
								YES	NO
								❐	❐
								❐	❐
								❐	❐
								❐	❐
								❐	❐
								❐	❐
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ADDITIONAL COPIES MAY BE PRINTED AS NEEDED

FORM 57, page 1

TRIPPING RECORD

DELUGE OR PRE-ACTION VALVES

Use previous page for dry pipe valves.
Caution: Do not use grease or pipe compounds on valve seats.
Valves should be tripped, cleaned and reset annually

Instructions: Use one card for each valve. Attach securely to valve. Record the data each time the valve trips or is tripped.

VALVE MANUFACTURER'S NAME		MODEL NUMBER		YEAR INSTALLED		VALVE NO./AREA CONTROLLED			
DATE TRIPPED	**CAUSE OF TRIPPING OR BY WHOM TRIPPED**	**STATIC WATER PRESSURE**	**SYSTEM AIR PRESSURE**	**TRIP POINT AIR PRESSURE**	**TRIP TIME MIN. – SEC.**	**DATE RESET**	**RESET BY**	**RED TAG PERMITS USED?**	
								YES	**NO**
								❐	❐
								❐	❐
								❐	❐
								❐	❐
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ADDITIONAL COPIES MAY BE PRINTED AS NEEDED
USE PREVIOUS PAGE FOR DRY-PIPE VALVE TRIPPING RECORD.

FORM 57, page 2

ANNUAL PERFORMANCE TEST RECORD OF PRESSURE REDUCING VALVES (PRV)

Property Name		Index Number	Account Number
Property Address		Operations Center Location	
INSTRUCTIONS	1. Conduct a Full Flow Test on each PRV on site in accordance with FM Global O.S. 3.11. 2. Use a separate form for each different valve model number. 3. Forward a copy of test form to the FM Global address shown above. 4. Keep a copy of form on site for review of test record.		
Valve Manufacturer's Name	**Model Number**	**Type of Valve** ❐ Pilot Operated ❐ Direct Acting	**Installation At:** ❐ Sprinkler System ❐ Hose Connection ❐ Fire Main ❐ Other
Year Installed			

Date & Initials	Location of Valve (e.g., Floor No. Standpipe No.)	Valve Setting Per Manufacturer Specs.	Static Pressure		Residual Pressure		Flow Rate (gpm)	Performance S = Satis. U = Unsatis.	Red Tag Permits Used		Comments/ Corrective Action Needed
			Inlet (psi)	Outlet (psi)	Inlet (psi)	Outlet (psi)			Yes	No	
									❐	❐	
									❐	❐	
									❐	❐	
									❐	❐	
									❐	❐	
									❐	❐	
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									❐	❐	
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									❐	❐	
									❐	❐	
									❐	❐	
									❐	❐	
									❐	❐	
									❐	❐	
									❐	❐	

The FM Global ***RED TAG PERMIT SYSTEM*** is used to guard against delayed reopening of valves. The FM Global ***RED TAG PERMIT SYSTEM*** should be used every time a sprinkler control valve is closed. When the valve is reopened, the drain should be flowed wide open to be sure there is no obstruction in the piping. The valve should then be relocked.

Were any valves closed since the last inspection? ❐ Yes ❐ No	
If Inspected by Contractor (Contractor's Name)	Signature:
Address	Date:
Reviewed By:	Date:

FORM 2707, page 1

ANNUAL PERFORMANCE TEST RECORD OF PRESSURE REDUCING VALVES (PRV)

Date & Initials	*Location of Valve (e.g., Floor No. Standpipe No.)*	*Valve Setting Per Manufacturer Specs.*	*Static Pressure*		*Residual Pressure*		*Flow Rate (gpm)*	*Performance S = Satis. U = Unsatis.*	*Red Tag Permits Used*		*Comments/ Corrective Action Needed*
			Inlet (psi)	Outlet (psi)	Inlet (psi)	Outlet (psi)			Yes	No	
									❐	❐	
									❐	❐	
									❐	❐	
									❐	❐	
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