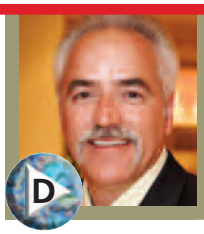
A TECHNICAL PUBLICATION OF ASSE'S FIRE PROTECTION PRACTICE SPECIALTY

Fireline

VOLUME 1 • NUMBER 1



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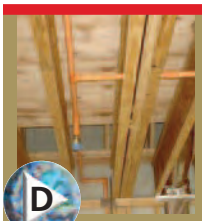

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Fire Sprinkler Systems

Inspection, testing and maintenance of sprinkler systems are critical to fire safety and a focus on many elements.

BY WALTER S. BEATTIE, CSP, CFPS, CSHM

This is the first in a series of articles on the inspection, testing and maintenance of water-based fire protection systems. This article, which focuses on wet pipe sprinkler systems, provides a practical review of what should be included in a typical program. Your program should be customized to meet your specific needs.

Many large corporations require that all of their facilities have automatic sprinkler protection. Countrywide, many municipalities also require certain occupancies to be sprinkler-protected. The municipality in which I live requires that all new residential construction have automatic sprinkler protection. Today, many more people than in the past work or live in buildings protected with automatic sprinklers.

Many large corporations require that all of their facilities have automatic sprinkler protection. Many municipalities also require certain occupancies to be sprinkler-protected.

Building owners rely on these systems to protect the facilities,

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processes and people. As with any emergency system, the time to test its readiness is not during a fire. The presence of sprinkler heads should never lull anyone into a false sense of security. The best way to know that the systems are ready is through a documented inspection, testing and maintenance program.

The primary standard in use in most companies and municipalities is NFPA 25, Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems. NFPA 25 establishes the minimum requirements for the periodic inspection, testing and maintenance of water-based fire protection systems. It is not an optimum standard. Rather, it is the minimum, and the level of action NFPA 25 requires is the base from which you should start and improve upon to meet your facility's needs.

Many facilities I visit do not have an adequately documented inspection, maintenance and testing program in accordance with NFPA 25. Some do not keep written records of inspections, while others conduct no testing. A facility without a documented program is not meeting NFPA 25's intent. The program must include documentation. If it is not documented, most authorities having jurisdiction (AHJs) will be skeptical that the activities have been completed.

A program that meets the minimums stated in NFPA 25 is an ongoing program, which typically requires weekly interaction with the systems. It should not be a program that is solely carried out by a sprinkler contractor. You are ultimately responsible for your systems, have staff familiar with your facility's systems and know what actions to take in the event of an emergency. It is unlikely that the sprinkler contractor will be on site at the time of a fire or other emergency that involves the fire protection systems.

Systems Included in NFPA 25

NFPA 25 addresses sprinkler, standpipe and hose, fixed water spray and foam water protection systems. It covers these systems' components, such as private fire service mains and appurtenances, fire pumps and water storage tanks, and valves that control system flow. It does not cover residential installations for one- and two-family dwellings and manufactured homes.

NFPA 25 also addresses proper impairment handling and reporting for instances when the system or a portion of it is out of service (which was discussed in the Winter 2008 *Fireline* article, "Handling Impairments to Fire Protection Systems"). It is important to follow an impairment procedure that includes the notification of department heads, the fire department, alarm company and insurance company, if applicable.

Hazardous operations, such as welding and cutting, should be prohibited during times of impaired protection. A hidden impairment is one about which no one is aware. This could be a shut valve that was not opened after a prior repair or a malfunction of a system component. Hidden impairments should be addressed quickly, and a follow-up study should be conducted to prevent a recurrence.

A comprehensive program includes the following elements:

•**Inspection.** A visual examination of a system to verify that it appears to be in operating condition and is free of physical damage.

•**Testing.** A physical trying or operation of a system or part of a system to ensure or prove that it is functioning properly, as intended or to an acceptable standard of operation.

•**Maintenance.** The work performed to repair and/or maintain equipment in operable condition.

The service may be performed by trained in-house staff or a qualified contractor. As with any inspection, maintenance and testing program, good recordkeeping is important. Written logs should be maintained, and relevant results should be retained for future reference or AHJ review. Ultimately, it is the property owner's responsibility to ensure that the systems are properly serviced. Tenants may also want to ensure that the work is completed satisfactorily. Management should review completed reports and correct deficiencies. An inspection and testing program is of limited value if identified system deficiencies are never corrected.

(Top): Wall-mounted, post-indication control valve with wrench, lock and valve tamper alarm supervision.

(Bottom): Post-indication control valve with wrench, lock and valve tamper alarm supervision.

Records, Plans & Calculations

It is important to maintain the original as-built installation drawings, hydraulic calculations, original acceptance test records, component device manufacturer's data sheets and letters regarding system review and acceptance. These documents are a valuable source of information when performing process of change reviews, developing emergency plans or changing the occupancy. Your insurer will most likely request this documentation to assist in its review of the facility.

NFPA 25 identifies the minimum requirements for the routine inspection, testing and maintenance of the various systems that may be present in water-based fire protection systems. The following chapters in NFPA 25 identify actions to take:

•Chapter 5—Sprinkler Systems

•Chapter 6—Standpipe and Hose Systems

•Chapter 7—Private Fire Service Mains

Sprinkler riser with inside butterfly control valve. The indicator in line with the pipe indicates open. If the indicator is aligned across the pipe, the valve is closed.

•Chapter 8—Fire Pumps
•Chapter 9—Water Storage Tanks
•Chapter 10—Water Spray Fixed Systems
•Chapter 11—Foam-Water Sprinkler Systems
•Chapter 12—Water Mist Systems
•Chapter 13—Valves, Valve Components and Trim
•Chapter 14—Obstruction Investigation
•Chapter 15—Impairments

Setting Up an Inspection Program

The inspection program should be written and documented. Some companies prefer to subcontract a portion of the inspection, maintenance and testing to a sprinkler contractor. This is a good option for many, especially those without an established maintenance department. A sprinkler contractor may also identify missed items. However, it is still your responsibility to maintain the system. Your employees should be as familiar with the fire and alarm system at your facility as they are with other building systems.

If a sprinkler contractor performs system testing and maintenance, you should also make it a practice to perform in-house inspections as well. Weekly visual checks can familiarize employees with the equipment, increase their confidence in using it and provide a better understanding of how the system works. Should a fire or emergency occur, they will know the location of control valves and can verify that the valves are open at the time of a fire.

For sprinkler systems, create a table or chart that lists valves, activity and frequency. Figure 1 shows a sample format used in many facilities. You may use a similar format to develop a table with site-specific frequencies.

Note the damage to the alarm equipment at the base of the post indicator valve. Also note the missing cap on the fire department connection.

Sprinkler Systems

Chapter 5 of NFPA 25 outlines the minimum requirements for sprinkler system inspection, testing and maintenance. In practice, many people think of their sprinkler system as the overall system, including the yard mains, fire pumps, water storage tanks and all associated valves. While the entire system acts together, each chapter in NFPA 25 covers a different component. The sprinkler system can be thought of as the portion of the sprinkler system, which is above the floor in the building.

A typical sprinkler system will be comprised of the riser, alarm check valve, riser appurtenances, alarm devices, fire department connection, pipes and fittings to hold the pipes together and to provide a fitting for the sprinkler heads, and hangers. Each component should be tested and listed/approved by a recognized laboratory such as Underwriters Laboratories (UL-listed) or Factory Mutual Approvals LLC (FM-approved).

Chapter 5 also contains a summary of items and activity for sprinkler systems (in Table 5.1, Summary of Sprinkler System Inspection, Testing and Maintenance). It also includes a reminder to notify the alarm supervisory service. If an alarm service monitors your fire protection system, a notification can help avoid false alarms and unnecessary fire department response. The alarm service should be called before conducting any test or procedure that could activate an alarm.

Likewise, after testing is completed, the alarm service should be called to verify that it received all alarms tripped and to place the alarm system back in service. Many alarm companies will take the system out of service for a predetermined

block of time (e.g., 2 or 4 hours). If you do not contact the company by the specified time, any alarms received after that time will be handled as an actual alarm, and the fire department will be dispatched. After two or three false alarms, many fire departments charge a service fee starting at approximately $500 and increasing in value for each subsequent alarm.

Weekly Checks

NFPA 25 recommends weekly checks of all sprinkler control valves. The inspection should verify that the valves are in the normal open or closed position. They should be properly sealed, locked or supervised to prevent tampering. All sprinkler valves should be readily accessible. Risers should not be blocked with pallets of stock, equipment or other goods, and outside valves should be accessible and not blocked by yard storage or snow banks. If the valve needs a wrench, one should be available. No leaks or corrosion should be visible, and the valve should be identified with a label or other suitable identification. If a facility has multiple risers on a common manifold, labeling is indispensable when the fire department needs to shut the proper valve.

Control valves control the flow of water to water-based fire protection systems. These valves are used to shut off water to main systems such as sprinkler systems, fire pumps and fire mains. For the purpose of the standard, control valves do not include hose valves, inspector's test valves, drain valves, trim valves for dry pipe, preaction and deluge valves, check valves or relief valves.

If a facility has backflow preventers of reduced pressure assemblies (RPAs) or reduced pressure detector assemblies (RPDAs), they should be visually inspected weekly to ensure that the differential-sensing valve relief port is not continuously discharging. Some of these valves have two independent spring-loaded valves separated by a differential-sensing valve. The differential-sensing valve has a relief port to atmosphere that discharges excess water resulting from supply system fluctuations. If the seats inside the unit leak, you may experience continuous leakage through the relief. Many times, the discharge is dumped on the floor of the utility closet or room. Continuous flow could create water damage.

Monthly Checks

Valves locked in the open position or supervised with an alarm service may be inspected monthly. While NFPA 25 permits the frequency to be expanded to monthly, depending on your circumstances, you may decide to continue weekly valve checks. Many corporate policies require each facility to maintain a weekly visual check as good practice. If your facility has public access or is in an area noted for vandalism, weekly checks may also be warranted.

Gauges should be checked monthly and repaired or replaced as needed. Damaged gauges and those not accurate to within 3% of the full scale should be recalibrated or replaced. Otherwise, gauges require 5-year replacement or testing. (Sprinkler systems that are not wet pipe systems will have additional checks not discussed here.)

Quarterly Checks

Mechanical waterflow devices, such as water motor gongs, should be tested quarterly. Alarm devices should be inspected quarterly to verify that they are free of physical damage. To clarify, testing is performed semiannually. On a quarterly basis, you should examine the devices to ensure that no physical damage is present, that covers are in place and appear to be in proper working condition.

Inspect the hydraulic nameplate installed on all hydraulically designed systems. Ensure that it is securely attached to the sprinkler riser and is legible. Keep this information in the facility's emergency plan. If the placard is lost, destroyed or missing, it can be an expensive ordeal to obtain the design information to replace it.

Fire department connections should be inspected. Any missing caps should be replaced immediately.

However, before doing so, internally inspect the piping to verify that there is no debris in it. Many items can fit into a fire department connection, such as candy wrappers, cigarette butts, stones, marbles, golf balls, tennis balls and soda cans. Anything left inside the piping will be flushed into sprinkler piping when the fire department pressurizes the system at the next preplan or fire alarm. Debris can plug pipes and sprinkler heads. Removing debris from a sprinkler system is an expensive and time-consuming process.

NFPA 25 establishes the minimum requirements for the periodic inspection, testing and maintenance of water-based fire protection systems.

If you cannot see from the head to the check valve by line of sight or with mirrors, a pipe camera should be employed, or the head and as much piping as needed should be removed so you can verify that no debris is present.

Semiannual Checks, Valve Tampers & Waterflows

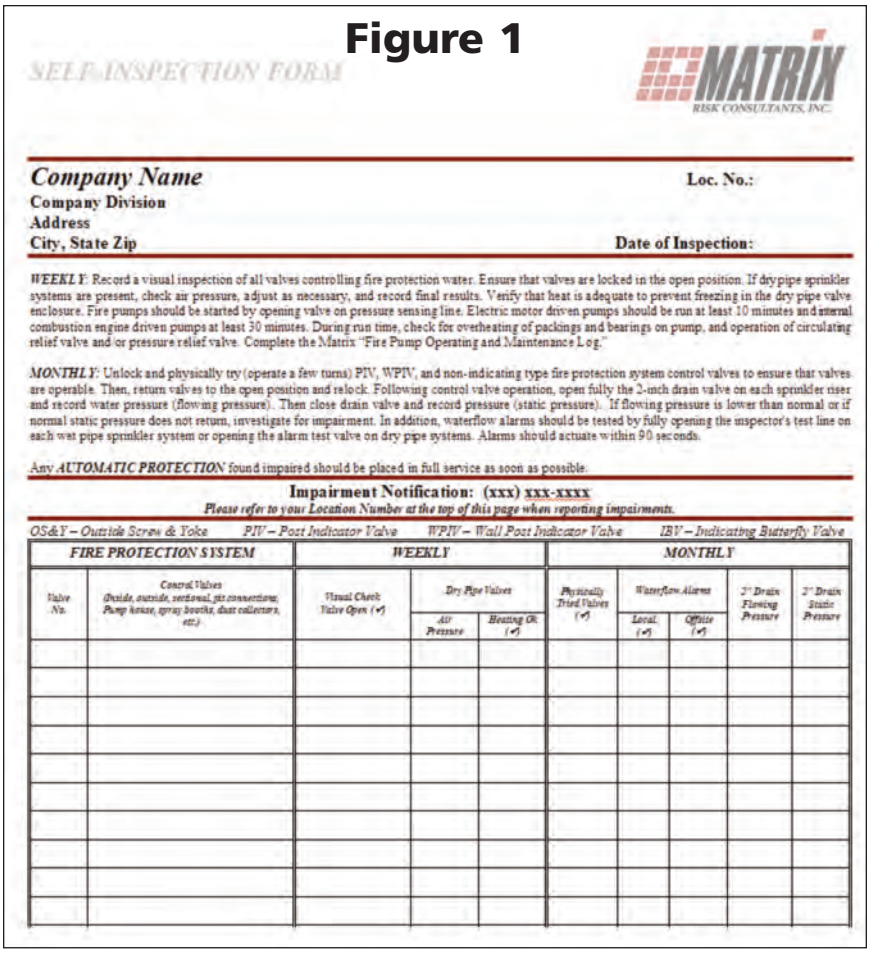
Valve tamper supervisory switches should be tested semiannually. The switch should actuate when the valve is moved from its normal position during the first two revolutions of a hand wheel or when the stem of the valve has moved one-fifth of the distance from its normal position. On valves where the tamper rod (finger) is exposed, moving the rod by hand does not count as a valid test. Moving the rod by hand may prove that the alarm circuit is active, but it does not prove that valve operation will produce a signal through the valve tamper switch.

Vane-type and pressure switch-type waterflow devices should be tested not less than semiannually. I suggest that waterflow alarm tests be conducted from the system inspec-

tor's test connection located at the end of the sprinkler system whenever one is provided. The inspector's test connection at the end of the system should have an orifice of the same size as the smallest sprinkler head used in the system. This proves that a single operating sprinkler head will properly activate the waterflow alarm.

Most contractors insert a sprinkler into the end fitting of the inspector's test connection, break out the fusible link and cut the frame for the sprinkler head off beyond the orifice. If your system has a 1-in. pipe or pipe elbow fitting with no restricted orifice, you are flowing the amount of water that would flow through several heads. In the event one head operates in the middle of the night or over an unoccupied weekend, waterflow activation may be delayed. This could result in increased water damage to a facility. If the alarm system requires repair on a regular basis, if it is old, or if it is protecting high-value items or critical operations, consider testing more frequently.

Figure 1



SELF-INSPECTION FORM

MATRIX RISK CONSULTANTS, INC.

Company Name Loc. No.:
Company Division
Address
City, State Zip Date of Inspection:

WEEKLY: Record a visual inspection of all valves controlling fire protection water. Ensure that valves are locked in the open position. If dry pipe sprinkler systems are present, check air pressure, adjust as necessary, and record final results. Verify that heat is adequate to prevent freezing in the dry pipe valve enclosure. Fire pumps should be started by opening valve on pressure sensing line. Electric motor driven pumps should be run at least 10 minutes and internal combustion engine driven pumps at least 30 minutes. During run time, check for overheating of packings and bearings on pump, and operation of circulating relief valve and or pressure relief valve. Complete the Matrix "Fire Pump Operating and Maintenance Log."

MONTHLY: Unlock and physically try (operate a few turns) PIV, WPIV, and non-indicating type fire protection system control valves to ensure that valves are operable. Then, return valves to the open position and relock. Following control valve operation, open fully the 2-inch drain valve on each sprinkler riser and record water pressure (flowing pressure). Then close drain valve and record pressure (static pressure). If flowing pressure is lower than normal or if normal static pressure does not return, investigate for impairment. In addition, waterflow alarms should be tested by fully opening the inspector's test line on each wet pipe sprinkler system or opening the alarm test valve on dry pipe systems. Alarms should actuate within 90 seconds.

Any *AUTOMATIC PROTECTION* found impaired should be placed in full service as soon as possible.

Impairment Notification: (xxx) xxx-xxxx
Please refer to your Location Number at the top of this page when reporting impairments.

OS&Y – Outside Screw & Yoke PIV – Post Indicator Valve WPIV – Wall Post Indicator Valve IBV – Indicating Butterfly Valve

FIRE PROTECTION SYSTEM		WEEKLY			MONTHLY				
Valve No.	Control Valves (Inside, outside, sectional, fire connections, Pump house, spray booths, dust collectors, etc.)	Visual Check Valve Open (✓)	Dry Pipe Valves: Air Pressure	Dry Pipe Valves: Heating Ok (✓)	Physically Tried Valves (✓)	Waterflow Alarms: Local (✓)	Waterflow Alarms: Offsite (✓)	2" Drain Flowing Pressure	2" Drain Static Pressure

Conducting a Waterflow Test

To conduct a waterflow test from the inspector's test connection, first verify that nothing is in the line of the water stream from the orifice. Then you only need to open the valve fully. This will flow water from the most remote portion of the sprinkler system. Within 90 seconds, the fire alarm should activate. If the waterflow alarm does not activate within 90 seconds of opening the inspector's test connection valve, a qualified person should adjust the waterflow device.

Some contractors install a device that serves as both the main drain and the inspector's test connection. These devices should have the proper orifice already installed and should be UL-listed and/or FM-approved for this application. These devices are installed in high-rise buildings because it is impractical to flow water to the outside at each floor.

Pressure-sensing waterflow devices are sometimes used, and they are installed above or downstream of the retard chamber. To test the alarm, I suggest that the end of the system inspector's test connection be used rather than the waterflow alarm test line located near the rear of the alarm check valve.

I have experienced waterflow alarm failures when opening the inspector's test connection because a portion of the alarm line between the alarm check valve and the retard chamber was plugged with rust and scale. The person testing the alarms had done so by only opening the alarm test valve. Using this valve bypasses a portion of pipe between the alarm check valve and the retard chamber. This portion of pipe is usually a ½-in. pipe, which can plug easily. When this occurs, the alarm may not activate upon operation of a sprinkler head.

Annual Checks

Annual inspections help identify system deficiencies. Many building owners will have a sprinkler contractor perform the annual testing even when the weekly, monthly, quarterly and semiannual checks are completed with in-house employees. It is a good learning experience for one or two employees to accompany the sprinkler service technician. The annual inspection is a thorough walkthrough of the facility.

Sprinklers are inspected from the floor level. Storage heights are reviewed to verify that storage is not too close to the sprinkler heads and that the minimum needed clearance is provided. Sprinkler piping and fittings are carefully inspected from floor level. Hangers and seismic bracing are inspected. Spare sprinklers are examined to verify they are in good condition and an adequate number is available.

Each control valve is operated through its full range and returned to its normal position. Post-indicator valves are opened until spring or tor-

sion is felt in the rod, indicating that the rod has not become detached from the valve. A main drain test is conducted at the system riser after the valve is operated. A main drain test should be conducted every time a control valve is closed and reopened, even if it is not time for the annual test.

Annually, before the onset of freezing weather, buildings with wet pipe systems should be inspected to verify that they are tight and adequately heated. A minimum of 40 °F (4.4 °C) is needed to prevent freezing.

Conducting a Main Drain Test

The main drain test is an important sprinkler test. It should be conducted annually and after each time a sprinkler control valve is operated. Before conducting this test, verify that the fire alarms are in test mode with the monitoring agency. Sometimes the waterflow alarm will activate and send a waterflow alarm signal to the alarm panel. Check the main drain discharge to ensure that no people are in the area, no automobiles are parked in front of the outlet and no other circumstances are present that could cause damage. Sprinkler water is not always clear and may have a slight odor.

1) Record the static pressure. Sometimes no alarm check valve is installed in the riser. If this is the case, there is usually one gauge that you will use for your readings. If an alarm check valve is installed, there are usually two gauges, one above and one below the alarm check valve. Note the static pressure on the supply side of the alarm check valve. The upper gauge may have a higher pressure. Use this gauge because pressure may be trapped above the check valve from nightly higher pressures caused by lower water usage or water utility supply pumps used for filling reservoirs in the city system.

2) Slowly open the main drain valve. Allow the water to run until the pressure reading on the gauge stabilizes. Record the pressure reading. This is the residual pressure. If it will not create problems, allow the water to run for 1 to 2 minutes until the water runs clear.

3) Slowly close the valve. This will help prevent a water hammer, which can cause damage such as broken or stressed fittings that may leak or let go. Then note the static pressure; it should be the same as the previous reading.

4) When testing is complete, make sure that valves are open and locked and that the alarms are placed back in service with the alarm company.

Main drain test results should be recorded so they can be used in the future to compare results. Key items to note are static pressure, residual pressure and the difference between the two. Slight changes in pressures from time to time or during different seasons may be noted and are usually not a concern.

Your specific area may have large differences in pressures from day to night or from summer to winter. If in doubt, contact the fire sprinkler contractor or water authority engineer. There are no correct or incorrect main drain pressures. Each sprinkler riser has its own results, and even risers in the same facility may not have the same reading due to many factors. It is important that consistent readings create a benchmark against which to compare all subsequent readings. Pressure changes that are not within a reasonable range of prior tests (usually within about 5 psi) should be investigated. They may indicate a deteriorating water supply, obstructions in the piping or a partially shut valve.

NFPA 25 lists the main drain test as an annual test; however, many insurance carriers recommend that this test be conducted quarterly or semiannually. Much can happen over the course of a year, and more frequent drain tests may be a good idea.

Less Frequent Checks & Testing Older Systems

When sprinklers have been in service for 50 years or more, they should be replaced or tested by a recognized testing laboratory acceptable to the AHJ. Representative samples from one or more sample areas should be tested, and the test procedures should be repeated at 10-year intervals. When sprinklers are 75 years old or older, the test procedures should be repeated at 5-year intervals. Sprinklers manufactured using fast-response elements that have been in service for 20 years should also be tested and retested at 10-year intervals.

Sprinklers manufactured prior to 1920 should be replaced. There is no testing option for heads this old. Solder used prior to 1920 is not of the same composition as today's sprinklers and has been known to malfunction.

Internal piping inspections should be conducted whenever foreign materials are known to be or believed to be in the pipes. This can occur through the fire department connection. It can also occur if care was not used in the performance of work on site or in the public water mains. Also, if you have a non-potable water supply taking suction from a pond, river or ocean, internal inspections should be conducted.

Conclusion

An effective maintenance program includes many items. Typically, fewer hidden impairments are found in properly inspected and well maintained systems. Wet pipe sprinkler systems are by far the most common sprinkler systems installed today. Future articles will examine other systems, such as dry pipe, deluge and preaction systems, underground piping, valves, hydrants, fire pumps and tanks. ✪

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