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

by Michael Swahn

Fire protection equipment represents a major capital investment for any facility and can lower the cost of insurance, limit the property damage from a fire and reduce the interruption to business resulting from a fire. Despite their obvious importance, many fire protection systems are not being properly maintained. This can reduce their overall effectiveness, possibly rendering them useless.

Improving the inspection, testing and maintenance of fire protection equipment is one of the most common recommendations made by Allianz Risk Consultants. It is believed that a major reason why the equipment is not properly maintained is that NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, is difficult to read and understand. This article will outline the more general requirements of NFPA 25 (2002 Edition) that deal directly with the inspection, testing and maintenance of wet-pipe sprinkler systems, dry-pipe sprinkler systems, fire pumps and water storage tanks.

Table 1 lists the leading reasons why sprinkler performance was unsatisfactory in 3,124 fires. The table indicates that in 57 percent of the cases (water shut off, inadequate maintenance, obstruction to water distribution, slow operation, defective dry-pipe valve or the system was frozen), the sprinkler system would have performed satisfactorily if the system had been properly maintained and inspected.

Table 1 Leading Reasons Why Sprinkler Performance is Unsatisfactory

Problem	Percentage of Cases
Water shut off	35.4
System not adequate for level of hazard in occupancy	13.5
Inadequate water supplies	9.9
Inadequate maintenance	8.4
Obstruction to water distribution	8.2
System designed for partial protection only	8.1
Faulty building construction	6.0
Antiquated system	2.1
Slow operation	1.8
Defective dry-pipe valve	1.7
Exposure fire	1.7
System frozen	1.4
Other or unknown	1.9
Total	100.0

"Automatic Sprinkler Performance Tables, 1970 Edition," *Fire Journal*, July 1970, page 37. Based on 3,134 fires.

What Should You Do and When Should You Do It?

We have provided a partial list of the most critical elements of a good fire protection equipment maintenance program. For a more complete list, along with corrective action measures, see NFPA 25 or *Fire Protection Systems: Inspection, Test and Maintenance Manual* by Wayne Carson and Richard Klinker. Both of these publications can be purchased from the National Fire Protection Association by calling (800) 344-3555.

You should note that the different inspection and maintenance activities listed in the following table require various levels of expertise. The experience level of the employees at a facility will dictate what activities can be done "in house" and what will need to be performed by a qualified contractor. In most cases, an activity with a high level of difficulty will require a qualified contractor to adequately perform the task. An honest evaluation of the skill level of the employees at a facility is needed to properly assign each activity.

In the appendix of this article, you will find more detailed guidelines for some of the maintenance required for fire pumps, water storage tanks, wet- and dry-pipe sprinkler systems.

Task And Frequency	Degree of Difficulty
Daily (during cold weather)	
Inspect dry-pipe sprinkler system enclosure temperature	Low
Check storage tank water temperature (if not monitored for low temperature)	Low
Weekly	
Inspect sprinkler system control valves (sealed)	Low
Check storage tank water temperature during cold weather (if monitored for low temperature)	Low
Test fire pump operation (no-flow condition)	Low
Monthly	
Inspect sprinkler system control valves (locked or monitored)	Low
Inspect storage tank water level (if not monitored for water level)	Low
Quarterly	
Inspect fire department connection	Low
Inspect sprinkler system pressure reducing & relief valves	Low
Inspect storage tank water level (if monitored for water level)	Low
Inspect water storage tank exterior	Low
Test sprinkler system waterflow alarm (pressure switch type)	Low
Test sprinkler system main drain (at least one system where the sole water supply is through a backflow preventer and/or pressure-reducing valves)	Low
Test dry-pipe sprinkler system priming water level	Medium
Test dry-pipe sprinkler system quick-opening device	High
Semiannually	
Test sprinkler system waterflow alarm (vane switch type)	Low
Annually	
Inspect sprinkler system (i.e. piping, fittings, sprinklers, hangers, valves, etc.)	High
Inspect low point drains on dry-pipe sprinkler systems	Low
Test sprinkler system control-valve operation	Low
Test sprinkler system main drain	Low
Test antifreeze sprinkler system solution (prior to freezing weather)	Medium
Trip test dry-pipe valve sprinkler system (control valve partially open)	High
Test performance of fire pump (flow condition)	High
Every Three Years	
Inspect water storage tank interior (corrosion protection provided)	High
Trip test dry-pipe valve sprinkler system (full flow)	High
Every Five Years	
Calibrate sprinkler system pressure gauge	Medium
Inspect sprinkler system piping for obstructions by flushing	High
Inspect water storage tank interior (corrosion protection not provided)	High
Every Fifty Years (every 10 years thereafter)	
Test sprinklers	High

Developing a Fire Protection Maintenance Program

There are many reasons why fire protection systems are not being maintained properly. Despite various roadblocks, facility management has the ultimate responsibility to ensure that all fire protection equipment is being properly maintained. When developing a fire protection equipment maintenance program, the following steps should be followed:

1. The applicable NFPA Standards should be reviewed. This will be NFPA 25 in most cases.
2. Guidelines specific to your facility should be developed.
3. The capabilities of the in-house people should be evaluated. Qualified contractors should be utilized for those tasks that are beyond the skill level of the in-house people.
4. Provide constant oversight monitoring. This is critical to ensure the work is performed correctly and in a timely manner.

More Information

If you would like more information on how to maintain fire protection equipment, contact a representative of Allianz Risk Consultants (ARC) at (404) 760-7891. ARC is also available to provide a training class at your site on how to maintain your fire protection equipment.

Appendix

Fire Pumps and Water Storage Tank Maintenance

Fire Pump (Weekly)

Before Pump Is Operated

Horizontal pumps

1. Check drip pockets under packing glands for proper drainage.
2. Check packing adjustment–approximately one drip per second is necessary to keep packing lubricated.
3. Observe suction and discharge gauges. Readings higher than suction pressure indicates leakage back from system pressure through either the fire pump or jockey pump check valves.

Weekly Observations While Pump Is Operating

Horizontal pumps

1. Read suction and discharge gauges–a difference between these readings indicates churn pressure, which should match rated pressure. The rated pressure can be found on the fire pump nameplate.
2. Observe packing glands for proper leakage for cooling of packing.
3. Observe discharge from casing relief valve on electric pumps and from cooling water discharge line on diesel pumps – adequate flow prevents pump case from overheating.

Vertical pumps

1. Read discharge gauge. The gauge pressure plus a lift factor should equal the rated pressure on fire pump nameplate. To calculate the lift factor multiply the distance in feet between the water level and the fire pump by 0.433.
2. Observe packing gland for proper leakage for cooling of packing.
3. Observe discharge from casing relief valve on electric pumps and from cooling water discharge line on diesel pumps – adequate flow prevents pump case from overheating.

Diesel engines

1. Observe discharge of cooling water from heat exchanger – if not adequate to prevent engine from overheating, check strainer in cooling system for obstructions. If still not adequate, adjust pressure-reducing valve for correct flow.
2. Check engine instrument panel for correct speed, oil pressure, water temperature and ammeter charging rate.
3. Check battery terminal connections for corrosion and clean if necessary.
4. After pump has stopped running, check intake screens, if provided. Also, change diesel system pressure recorder chart and rewind if necessary.

Fire Pump (Annually)

An annual flow test of each pump assembly should be conducted under minimum, rated and peak flows by controlling the quantity of water discharged through approved test devices. A contractor who is familiar with the equipment generally conducts this test.

Water Storage Tank (Daily or Weekly)

During very cold weather, the temperature of the water in the tank should be checked daily to ensure it does not drop below 40°F. If the water temperature is continuously monitored, the frequency may be reduced to weekly.

Water Storage Tank (Monthly or Quarterly)

The water level and the condition of the water in the tank should be visually inspected monthly. If the water level is continuously monitored, the frequency may be reduced to quarterly. The tank exterior should also be visually inspected quarterly.

Water Storage Tank (every 3-5 years)

The interior of the tank should be inspected by a qualified contractor every three years for signs of rust, corrosion and collection of debris. If corrosion protection is provided inside the tank, the frequency may be reduced to every five years.

Sprinkler Systems Maintenance

Control Valves (Weekly or Monthly)

The method of supervision for a control valve will determine whether weekly or monthly inspections are required. If a control valve is sealed, it should be inspected weekly. If the valve is locked, or has a tamper switch, the inspection frequency may be reduced to monthly. The valve inspection should verify that the valves are in the following condition:

1. In the normal open or closed position.
2. Properly sealed, locked or supervised.
3. Accessible.
4. Provided with appropriate wrenches.
5. Free from external leaks.
6. Provided with appropriate signs such as Sprinkler System No. 1, Divisional Valve No. 1.

Fire Department Connection (Quarterly)

The inspection should verify the following:

1. The fire department connections are visible and accessible.
2. Couplings or swivels are not damaged and rotate smoothly.
3. Plugs or caps are in place and undamaged.
4. Gaskets are in place and in good condition.
5. Identification signs are in place.
6. The check valve is not leaking.
7. The automatic drain valve is in place and operating properly.

Waterflow Alarms (Quarterly or Semiannually)

Test the waterflow alarms for each sprinkler system quarterly or semiannually using the inspector's test connection (quarterly for pressure-type switch and semiannually for vane-type switches). The inspector's test connection simulates the activation of the most remote sprinkler. The automatic fire alarm system should activate within 90 seconds after the inspector's test connection is fully opened. All alarms transmitted off premises should be verified that alarms were received by the alarm monitoring company.

Main Drain (Quarterly or Annually)

A main drain test should be conducted quarterly or annually and any time the control valve has been closed to determine whether there has been a change in the condition of the water supply piping and control valves. Static and flowing (residual) water pressures should be recorded and compared to previous test results to determine if a possible obstruction exists.

Control Valves (Annually)

Each control valve should be operated annually through its full range and returned to its normal position. Post indicator valves should be opened until spring or torsion is felt in the rod, indicating that the rod has not become detached from the valve. Post indicating and outside screw and yoke valves should be backed off one-quarter turn from the fully open position to prevent jamming.

Pressure Gauges (5 years)

Replace or calibrate all gauges every five years.

Sprinklers (20 – 50 years)

When sprinklers reach 50 years of age, a sample of sprinklers should be submitted to a nationally recognized laboratory (i.e. Underwriter's Laboratories) for testing to ensure they are in good working condition. A representative sample of sprinklers should consist of a minimum of four sprinklers or one percent of the number of sprinklers per individual sprinkler sample, whichever is greater. For fast-response sprinklers, testing should be conducted at 20 years of age. Testing for all sprinklers should be conducted every 10 years thereafter.

Dry-Pipe Sprinkler Systems Maintenance

Enclosure (Daily During Cold Weather)

Enclosures that are designed to keep a sprinkler riser from freezing should be inspected daily during cold weather to ensure its integrity and that the enclosure temperature remains above 40°F.

Priming Level for Dry-Pipe Valves (Quarterly)

High-priming water levels can affect the operation of supervisory air or nitrogen pressure maintenance devices. Test the water level as follows:

1. Open the priming-level test valve.
2. If water flows, drain it.
3. Close the valve when water stops flowing and air discharges.
4. If air discharges when the valve is opened, the priming-water level could be too low. To add priming water, refer to the manufacturer's instructions.

Quick-Opening Device (Quarterly)

A quick-opening device should be tested in the following manner:

1. Close the system control valve.
2. Open the main drain valve and keep it in the open position.
3. Verify that the quick-opening device control valve is open.
4. Open the inspector's test valve. A burst of air from the device indicates that it has tripped.
5. Close the device's control valve.
6. Return the device to service in accordance with the manufacturer's instructions and return the system to service.

Low Point Drains (Annually)

The low-point drains are provided to collect condensate inside the sprinkler piping. Each year, before the onset of freezing weather, all low-point drains should be drained to ensure that there is no condensate that can freeze and damage the sprinkler piping.

Dry-Pipe Valves (Annually)

Dry-pipe valves should be trip tested on an annual basis in warm weather with the control valve partially open.

Dry-Pipe Valves (Every 3 years)

A full-flow trip test generally requires at least two individuals; one of whom is situated at the dry pipe valve while the other is at the inspector's test connection. If possible, they should be in communication with each other. A full-flow trip test is conducted as follows:

1. The main drain valve is fully opened to clean any accumulated scale or foreign material from the supply water piping. The main drain valve then is closed.
2. The system air or nitrogen pressure, and the supply water pressure is recorded.
3. The system air or nitrogen pressure is relieved by opening the inspector's test connection valve completely. Concurrent with opening the valve, both testers start their stopwatches. If two-way communication is not available, the tester at the dry valve is to react to the start of downward movement on the air-pressure gauge.
4. The tester at the dry-pipe valve records the air pressure at which the valve trips and records the tripping time.
5. The tester at the inspector's test connection valve records the time at which water flows steadily from the test connection. This time is recorded for comparison purposes to previous tests and is not meant to be a specific pass/fail criterion. Note that NFPA 13, *Standard for the Installation of Sprinkler Systems*, does not require water delivery in 60 seconds in all cases.
6. When clean water flows, the test is terminated by closing the system control valve.
7. The air or nitrogen pressure and the time elapsed are to be recorded as follows: a) from the complete opening of the inspector's test connection valve to the tripping of the valve. b) from the complete opening of inspector's test connection valve to the start of a steady flow from the inspector's test connection.
8. All low-point drains are opened and then closed when water ceases to flow.
9. The dry-pipe valve and quick-opening device (if provided) are reset in accordance with the manufacturer's instructions and the system is returned to service.