INSPECTION, TESTING AND MAINTENANCE OF WATER-BASED FIRE PROTECTION SYSTEMS

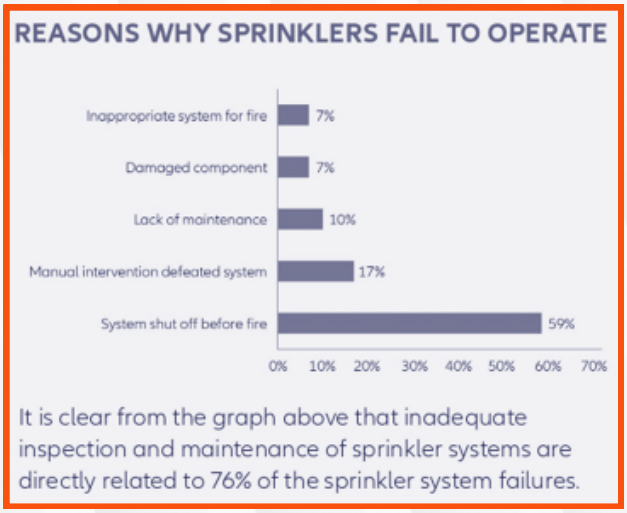
INTRODUCTION

Water-based fire protection systems are clearly one of the most effective methods of limiting property damage and business interruption resulting from a fire. Despite their obvious importance, many fire protection systems are not being properly maintained. This can reduce their overall effectiveness and in some cases, render them useless.

Improving the inspection, testing and maintenance of fire protection equipment is one of the most common recommendations made by Allianz Risk Consulting.

This document will outline the most critical requirements of NFPA 25, *Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems*, and will deal directly with the care and maintenance of wet pipe sprinkler systems, dry pipe sprinkler systems, fire pumps, fire hydrants and water storage tanks.

In a study conducted between 2010 and 2014, sprinklers operated in 92% of fires in sprinklered properties. The graph below represents the remaining 8% of fires in which sprinklers failed to operate.



It is clear from the graph above that inadequate inspection and maintenance of sprinkler systems are directly related to 76% of the sprinkler system failures.

WHAT SHOULD YOU DO AND WHEN SHOULD YOU DO IT?

Table 1 lists the most critical elements of a good maintenance program for water-based fire protection equipment. For a more complete list, please refer to NFPA 25. Please note that the different maintenance activities listed in the following table require various levels of expertise. The experience level of the employees at a facility will dictate which activities can be completed 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

TABLE 1

Task and Frequency	Degree of Difficulty
Daily (during cold weather)	
Inspect dry-pipe valve enclosures for temperature (if not monitored for low temperature)	Low
Inspect water storage tank heating system (if not monitored for low temperature)	Low
Weekly	
Inspect dry-pipe valve enclosures for temperature during cold weather (if monitored forlow temperature)	Low
Inspect sprinkler system control valves (sealed)	Low
Check storage tank water temperature (if not monitored for low temperature)	Low
Test fire pump operation for all diesel engine driven fire pumps and certain electric fire pumps (no-flow condition)	Low
Inspect diesel engine driven fire pump fuel tanks (should be at least 2/3 full)	Low
Monthly	
Inspect sprinkler system control valves (locked or supervised)	Low
Inspect water level in storage tanks (if not monitored for water level)	Low
Test electric motor driven fire pump operation (no-flow condition)	Low
Quarterly	
Check storage tank water temperature (if monitored for low temperature)	Low
Inspect water level in storage tanks (if monitored for water level)	Low
Test sprinkler system main drains (at least one system where the sole water supply is through a backflow preventer and/or pressure-reducing valve)	Low
Test dry-pipe sprinkler system priming water level	Medium
Test dry-pipe sprinkler system quick-opening device	High
Test dry-pipe sprinkler system low air pressure alarm	Low
Semiannually	
Test sprinkler system waterflow alarm	Low
Test sprinkler control valve supervisory switches	Low
Annually	
Inspect sprinkler system (i.e. piping, fittings, sprinklers, hangers, etc.)	High
Drain low point drains on dry-pipe sprinkler systems	Low
Test sprinkler system control valve operation	Low
Test sprinkler system main drains	Low
Test antifreeze sprinkler system solution (prior to freezing weather)	High
Trip test dry-pipe valve sprinkler system (control valve partially open)	High
Test fire hydrants (flowing)	Medium
Inspect fire hydrants	Low
Test performance of fire pump (flow condition)	High
Every Three Years	
Inspect water storage tank interior (corrosion protection not provided)	High
Trip test dry-pipe valve sprinkler system (full flow)	High
Every Five Years	
Inspect sprinkler system piping for obstructions	High
Inspect water storage tank interior (corrosion protection provided)	High
Test sprinklers in harsh environments or extra-high temperature sprinklers	
Every 10 to 75 Years (every 5 to 10 years thereafter) Test sprinklers	High

DEVELOPING A FIRE PROTECTION MAINTENANCE PROGRAM

Despite various roadblocks, facility management has the ultimate responsibility to ensure that all fire protection equipment is being properly maintained. NFPA 25 states the following:

"The property owner or designated representative shall be responsible for properly maintaining a water-based fire protection system."

When developing a maintenance program for water based fire protection equipment, the following steps should be followed:

1. Review NFPA 25.
2. Develop guidelines specific to your facility.
3. Evaluate the capabilities of employees to perform the required maintenance. Utilize qualified contractors for those tasks that are beyond the skill level of employees.
4. Provide constant oversight and monitoring. This is critical to ensure the work is performed correctly and in a timely manner.

QUESTIONS OR COMMENTS?

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APPENDIX

FIRE PUMP MAINTENANCE

FIRE PUMP (WEEKLY OR MONTHLY)

A weekly no-flow test (churn test) should be conducted for all diesel engine driven fire pumps and for the following electric motor driven fire pumps:
1. Fire pumps that serve fire protection systems in buildings that are beyond the pumping capacity of the fire department
2. Fire pumps with limited service controllers 3. Vertical turbine fire pumps
4. Fire pumps taking suction from ground level tanks or a water source that does not provide sufficient pressure to be of material value without the pump
A monthly no-flow test frequency is permitted for electric motor driven fire pumps not identified in the list above.
During the no-flow test, the diesel engine driven fire pumps should be operated for 30 minutes and the electric motor driven fire pumps should be operated for 10 minutes.

OBSERVATIONS BEFORE PUMP IS OPERATED

HORIZONTAL PUMPS

1. Check drip pockets under packing glands for proper drainage. Standing water in drip pockets is the most common cause of bearing failure.
2. Check packing adjustment - approximately one drip per second is necessary to keep packing lubricated.
3. Observe suction and discharge gauges. Readings higher than suction pressure indicate leakage back from system pressure through either the fire pump or jockey pump check valves.

OBSERVATIONS WHILE PUMP IS OPERATING

HORIZONTAL PUMPS

1. Record suction and discharge pressure from gauges. The difference between these readings indicates the churn pressure, which should match the maximum rated pressure indicated on the fire pump nameplate.
2. Observe packing glands for proper leakage for cooling of packing. Adjust gland nuts if necessary.
3. Observe water discharge from casing relief valve on electric motor driven fire pumps and from cooling water discharge line on diesel engine driven fire pumps - adequate flow prevents pump case from overheating.

VERTICAL PUMPS

1. Record discharge pressure from gauge. The discharge pressure plus a lift factor should equal the maximum rated pressure indicated on the fire pump nameplate. To calculate the lift factor, multiply the distance in ft. or m between the water level and the fire pump by 0.433 psi/ft. or 0.098 bar/m.
2. Observe packing gland for proper leakage for cooling of packing.
3. Observe water discharge from casing relief valve on electric motor driven fire pumps and from cooling water discharge line on diesel engine driven fire 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. Check diesel fuel tank levels . Tanks should be at least 2/3 full.
5. 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 no-flow (churn), rated flow, and 150% of the pump rated flow by controlling the quantity of water discharged through test devices. For each flow condition, record suction and discharge pressures from gauges, as well as speed. When the fire pump test results do not meet or exceed 95% of the rated flow and pressure, the cause of the performance reduction should be identified and corrected as necessary. A contractor who is familiar with the equipment generally conducts this test.

WATER STORAGE TANK MAINTENANCE WATER STORAGE TANK (WEEKLY OR QUARTERLY)

During cold weather, the temperature of water in the tanks should be inspected and recorded weekly to ensure it does

not drop below 40°F (4 °C). If the water temperature is continuously monitored, the frequency may be reduced to quarterly.

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 for signs of obvious damage

WATER STORAGE TANK (EVERY THREE TO FIVE YEARS)

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

FIRE HYDRANTS MAINTENANCE

FIRE HYDRANTS (ANNUALLY)

Hydrants should be tested annually to ensure proper functioning. Each hydrant should be opened fully and water flowed until all foreign material has cleared. Flow should be maintained for at least one minute. After operation, dry barrel and wall hydrants should be observed for proper drainage from the barrel. Hydrants should also be lubricated annually to ensure that all stems, caps, plugs, and threads are in proper operating condition.

SPRINKLER SYSTEM 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. Post indicator valves (PIVs) are provided with correct wrenches
5. Free from external leaks
6. Provided with appropriate identification signs

WATERFLOW ALARMS (SEMIANNUALLY)

Test the waterflow alarms for each sprinkler system procedure:

1. Test samples should be taken at the top and bottom of each system.
2. The specific gravity of each solution should be

semiannually using the inspector's test connection for wet pipe systems and using the bypass connection for dry pipe, preaction, or deluge systems. The inspector's test

connection simulates the activation of one 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 they were received by the alarm monitoring company.

VALVE SUPERVISORY SWITCHES (SEMIANNUALLY)

Test the valve supervisory switches semiannually by ensuring a supervisory signal is received when the valve is moved from its normal position during either 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.

MAIN DRAIN (QUARTERLY OR ANNUALLY)

A main drain test should be conducted annually for each water supply lead-in to a building's water-based fire protection system to determine whether there has been a change in the condition of the water supply. For systems where the sole water supply is through a backflow preventer and/or pressure reducing valve, the main drain test of at least one system downstream of the device should be conducted on a quarterly basis. The static and residual (flowing) water pressures should be recorded and compared to previous test results. If there is a 10% reduction in flowing water pressure when compared to previously performed tests, the cause of the reduction should be identified and corrected as necessary.

SPRINKLER SYSTEM COMPONENTS (ANNUALLY)

The components of a sprinkler system (i.e., piping, fittings, sprinklers, hangers, etc.) should be inspected annually from floor level to ensure they are in good condition and free of physical damage. This is normally completed by an experienced contractor.

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 indicator and outside screw and yoke valves should be backed off one-quarter turn from the fully open position to prevent jamming.

ANTIFREEZE SYSTEMS (ANNUALLY)

Before the onset of freezing weather, the antifreeze solution should be tested using the following checked using a hydrometer with a suitable scale or a refractometer having a scale calibrated for the antifreeze solution.

3. If any of the samples exhibits a concentration in excess of what is permitted by NFPA 25 or the antifreeze is found to be a type that is no longer permitted, the system should be emptied and refilled with a new acceptable solution. If a concentration greater than what is currently permitted by NFPA 25 was necessary to keep the fluid from freezing, alternate methods of preventing the pipe from freezing should be employed.
4. If any of the samples exhibits a concentration lower than what is necessary to keep the fluid from freezing, the system should be emptied and refilled with a new acceptable solution.

OBSTRUCTION INVESTIGATION (FIVE YEARS)

The sprinkler piping should be inspected every five years for the presence of foreign material. The inspection should be performed at the following four points at a minimum; system valve, riser, cross main and branchline.

SPRINKLERS (5 TO 75 YEARS)

Sample sprinklers should be submitted to a recognized testing laboratory (i.e. Underwriter's Laboratories) for field service testing on the following schedule:

SPRINKLER TYPE	TESTING INTERVAL
Sprinklers in harsh environments	Every 5 years
Extra-High temperature sprinklers	Every 5 years
Dry Sprinklers	At 10 years and every 10 years thereafter
Fast-Response Sprinklers	At 20 years and every 10 years thereafter
Standard Sprinklers	At 50 years and every 10 years thereafter
Standard Sprinklers	At 75 years and every 5 years thereafter
Standard Sprinklers	Replace if manufactured prior to 1920

A representative sample of sprinklers should consist of a minimum of four sprinklers or 1% of the number of sprinklers per individual sprinkler sample, whichever is greater. Where one sprinkler within a representative sample fails to meet the test requirement, all sprinklers within the area represented by that sample should be replaced

DRY-PIPE SPRINKLER SYSTEM

MAINTENANCE ENCLOSURE (DAILY OR WEEKLY DURING COLD WEATHER)

Valve enclosures for dry pipe valves subject to freezing should be inspected daily during cold weather to verify a minimum temperature of 40°F (4 °C). If the valve enclosures are equipped with low temperature alarms, the frequency may be reduced to weekly

PRIMING WATER 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 quarterly 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)

If provided, quick-opening devices should be tested quarterly 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 condensation 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.

LOW POINT DRAINS (ANNUALLY)

Dry-pipe valves should be trip tested on an annual basis in warm weather with the control valve partially open. A partial flow trip test is conducted as follows:
1. Fully open the main drain valve to clean any accumulated scale or foreign material from the supply water piping.

2. Close the control valve to the point where additional closure cannot provide flow through the entire area of the drain outlet.
3. Close the valve controlling flow to the device if a quick opening device is installed.
4. Record the system air or nitrogen pressure and the supply water pressure.
5. Relieve system air or nitrogen pressure by opening the priming level test valve or the inspector's test valve.
6. Note and record the air or nitrogen pressure and supply water pressure when the dry pipe valve trips.
7. Immediately close the system control valve and open the main drain valve to minimize the amount of water entering the system piping.
8. Trip test the quick-opening device, if installed, in accordance with the manufacturer's instructions.
9. Open all low point drains and close when water ceases to flow.
10. Reset the dry pipe valve and quick-opening device, if installed, in accordance with the manufacturer's instructions and return the system to service.

DRY-PIPE VALVES (EVERY THREE 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 are 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 pipe 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 the 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.