Freezing of Water-Based Fire Protection Systems

For water-based fire protection systems (e.g., automatic sprinkler systems, standpipe systems, and fire hydrants), freezing of water in the piping system is an impairment requiring immediate attention. Ice blockages within the pipe may prevent the system from operating properly in the event of fire. During periods of very cold weather, the likelihood of these systems freezing increases substantially.

While most fire protection freezing impairments occur because of cold weather, some systems can be impaired by cold temperatures created by internal operations, such as cold storage and refrigerated warehousing. Fire protection systems for these areas should be designed as dry or pre-action sprinkler systems to account for the lower temperatures; however, an accidental activation of the system, improper system restoration following activation, or leaking valves can cause these systems to freeze.

Blockage is not the only concern of water freezing within pipes. Freezing may cause pipes to burst, resulting in considerable water damage. This risk management alert provides information on methods to prevent the freezing of fire protection system piping, details the steps to be taken in the event of a freezing impairment, highlights concerns related to the use of antifreeze in sprinkler systems, and provides suggested precautions to further reduce the risk of fire.

Preventing Freezing

Water-based fire protection systems located in areas where the temperature may fall below 40°F (4°C) should be protected from freezing, generally by heating or location. Broken windows, ill-fitting doors, and other conditions that allow heat loss should be repaired. Heat should be provided by the facility's heating system. The use of temporary heating equipment, such as salamanders and other unvented, portable fuel-burning heaters, is not recommended, since it introduces fire and health hazards. Other methods to protect fire protection systems from freezing include:

- Installing a dry-pipe or pre-action sprinkler system in the affected area.
- Adding an antifreeze system to the fire protection system.
- Providing heated or adequately insulated enclosures for any pipes exposed to low temperatures.
- Covering underground pipes by adding a greater depth of earth over the pipes, if practical.
- Utilizing heat trace, listed for underground use, on underground piping, when burial depth is insufficient to protect against ground freezing. However, heat trace (i.e., heat tape) should not be used for aboveground piping and valves.
- Keeping snow, water, and ice away from hydrants, valves, and standpipe connections. This also will ensure that these items are accessible when needed.
- Repairing leaking or damaged hydrants, such as hydrants that have cracked valve seats, damaged drains, or where underground water is being forced into the barrel through the drain.

Antifreeze Systems

Historically, property owners have used antifreeze to prevent water from freezing in sprinkler systems where the piping was exposed to freezing temperatures. Most often, these systems were used to protect smaller areas, such as outside loading docks, small walk-in freezers, and similar exposures. However, they could also be for larger areas, such as refrigerated warehouses and in residential properties, where the piping is run in areas that are not protected against freezing temperatures, such as attic spaces.

Antifreeze systems were often chosen because of the reduced cost of equipment, installation, and maintenance. However, in recent years, the cost of backflow prevention devices and the advent of less costly dry-pipe valve assemblies have made antifreeze systems less economical than they were in the past.

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It is important to remember that by definition, an antifreeze system has an antifreeze solution in the piping, but once that solution is discharged, plain water then flows through the piping. As such, following a discharge, the system must be carefully drained and refilled with solution. In the late 2000s, a number of losses occurred where antifreeze-based, residential sprinkler systems were suspected of actually accelerating fires. As a result of extensive research conducted by several organizations, including the Fire Protection Research Foundation (FPRF), the National Fire Protection Association (NFPA) prohibited the use of traditional antifreeze solutions and began requiring the use of listed non-combustible antifreeze solutions in new antifreeze systems, subject to limited exceptions.

See the NFPA Antifreeze website at **www.nfpa.org/antifreeze** for additional information.

NFPA 25, Chapter 5.3.4 Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, provides details on specific tests and requirements for the antifreeze system.

Managing System Impairments

In the event of system impairment due to freezing, the property's fire protection system impairment program should be followed. A fire protection impairment program can be used to reduce the threat to property by limiting the time that fire protection is unavailable, establishing alternate fire detection and alarm activation methods, and providing substitute fire suppression systems.

NFPA 25 includes minimum requirements for a water-based fire protection system impairment program. At a minimum, an impairment program should include procedures for:

- Suspension of hazardous operations
- Notification of affected employees, Emergency Response Teams, and the local fire department
- Compartmentalization of work areas to restrict fire spread
- Temporary fire protection
- Identification of impaired systems
- Expeditious repair procedures

It is also recommended that the insurance carrier and local fire department be notified of the impairment and provided with the following information: the nature and location of the problem, the estimated time of the impairment, and what precautions are being taken until full service is restored.

Repairing Frozen Systems

The type of protection, location, and degree of freezing will dictate what corrective steps should be used to thaw and repair a water-based suppression system. A qualified sprinkler contractor should be consulted prior to attempting to thaw or repair damaged piping, valves, or other system components. To facilitate repairs, portions of the system, only as large as is necessary, should be shut off one at a time; repairs affected; and the section restored to service as soon as possible.

Thawing Piping

Sprinkler piping may be thawed, if not severely frozen, by pouring hot water over cloths wrapped around the pipe; a hose connected to a hot water faucet may be suitable to supply the hot water; otherwise, pails may be used. Electrical resistance heating may also be a practical method to thaw piping but should be performed by qualified personnel under competent supervision. Temporary use of electric heating cables (i.e., heat tape) may provide an acceptable alternative to this method. Severe freezing of sprinkler piping may require removal of the frozen pipe sections to a heated area until the ice has melted.

Standpipe systems are generally subject to the same procedures as sprinkler system piping; however, should hoses contain water that freezes, the hoses should be checked for damage, pressure tested, and dried before being placed back in service.

If it is necessary to use temporary heating units, only listed units should be used. All combustibles should be removed from the area, non-essential employees should be prohibited from the area, and continuous monitoring of carbon monoxide should be provided.

Underground Piping

Only qualified personnel, such as sprinkler or water and sewer contractors, should attempt repairs to underground piping that has frozen. Aside from actual removal and replacement (which is difficult in frozen earth), there are two other principal means of repairing such piping. One method employs a steam line that is inserted in the frozen pipe to melt the ice plug. Electric resistance heating may also be employed, if practical.

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Fire Hydrants

Freezing of fire hydrants can be caused by any one of a number of problems, including improper draining, groundwater seeping into a hydrant barrel, and leaking valve seats. Property owners with privately-owned hydrants may obtain hydrant-thawing devices from the water department; these devices are specifically designed for thawing hydrants and represent one of the best means of restoring service. Thawing of hydrants also may be accomplished by means of a steam line that is inserted through one of the hydrant outlets. Another method involves placing quicklime (calcium oxide) and hot water in the hydrant barrel; the resulting exothermic reaction will melt the ice. However, although this may be an effective method, it requires thorough and immediate flushing of the hydrant afterwards to prevent corrosion.

After thawing out the hydrant, the water should be pumped out and the hydrant checked for further leakage. If leakage continues, it may be necessary to excavate around the hydrant and plug or repair the drain. Where excavation is not practical, a non-flammable antifreeze may be poured into the hydrant to prevent freezing of any water that enters the barrel; however, the use of salt or other corrosive materials is not recommended.

The setting of a fire around a hydrant is not recommended, as it is not a very efficient method and may result in damage to the hydrant, which may require replacement of the hydrant and its barrel.

Fixtures and Fittings

Any time freezing has occurred, the affected materials (e.g., pipe, fittings, and sprinkler heads) should be thoroughly checked for damage, and damaged items should be replaced. Valves should be heated slowly and closely monitored to prevent overheating and damage to internal seals. Alarm check valve assemblies should be opened and allowed to thaw and drain. Cracked or otherwise damaged items can result in water leakage and costly water damage. Alarm valve assemblies should be opened and allowed to thaw and drain.

Restoration

After the impairment, restoration of fire protection equipment must be verified. A hydrostatic pressure test should be conducted on all affected piping. Additionally, each control valve should be operated 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 one-quarter turn from the fully open position to prevent jamming.

After the fire protection is verified to be back in service, the entities that were notified of the impairment, such as the fire department or insurer, should again be notified that the fire protection had been restored to full service.

References

1. National Fire Protection Association (NFPA). *Fire Protection Handbook*. 20th ed. Quincy, MA: NFPA, 2008.
2. *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*. NFPA 25. Quincy, MA: NFPA, 2020.
3. *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*. NFPA 24. Quincy, MA: NFPA, 2019.
4. *Standard for the Installation of Sprinkler Systems*. NFPA 13. Quincy, MA: NFPA, 2019.

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