BY JAMES STENQVIST, CPD, LEED AP

Water-based Fire Protection Systems

Water has always been the most common substance used to extinguish a fire. Water is usually readily available, is nontoxic, can be stored at atmospheric pressure and normal temperatures, takes the heat out of a fire, and is inexpensive. It is better than any other recognized liquid for fighting the majority of fires.

In designing a fire protection system, the engineer must determine which system to select based on each system's pros, cons, and code requirements. Each system has its own unique applicable use, which depends on the type of structure to be protected, the contents of the building, the severity of the fire, the anticipated fire growth rate, water sensitivity, ambient freezing conditions, and desired time until activation.

WET PIPE SPRINKLER SYSTEMS

Wet systems (Figure 1) are the most straightforward and most widespread type of sprinkler system installation, with relatively few components. As the name illustrates, a wet pipe system is one in which water is constantly contained within the sprinkler piping. The wet system employs fixed fire sprinkler heads and sprinkler piping filled with pressurized water supplied from a dependable source at all times. When a sprinkler head activates or its fusible link melts, water is discharged immediately onto the fire. Water is discharged continually through the sprinklers that have activated over or near the fire, thereby minimizing water damage. Only sprinklers in the area of the fire that have reached the temperature required to melt, usually between 165°F and 212°F, will discharge water. Upon operation, the sprinklers distribute the water over the area to control or extinguish the fire.

The alarm check valve is a key component of the wet pipe system. It is designed to indicate when a sprinkler has operated as well as to provide a system check valve. The alarm check valve serves as a check valve by holding the pressurized water above the clapper and preventing reverse flow from the sprinkler piping. The valve initiates an alarm during a sustained flow of water (such as the flow required by an open sprinkler) by operating a water motor alarm and/or alarm pressure switch. When it is installed with the water motor alarm (if required by code

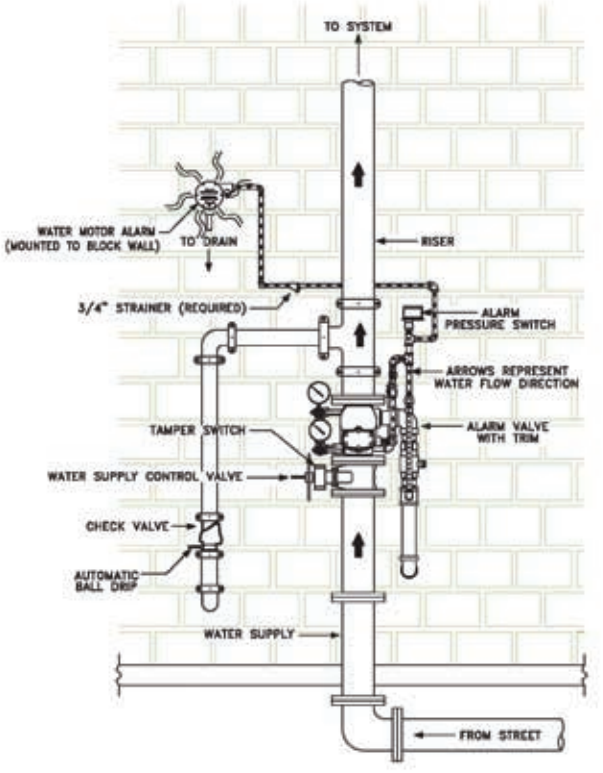

Figure 1 Diagram of a typical wet-pipe service entrance

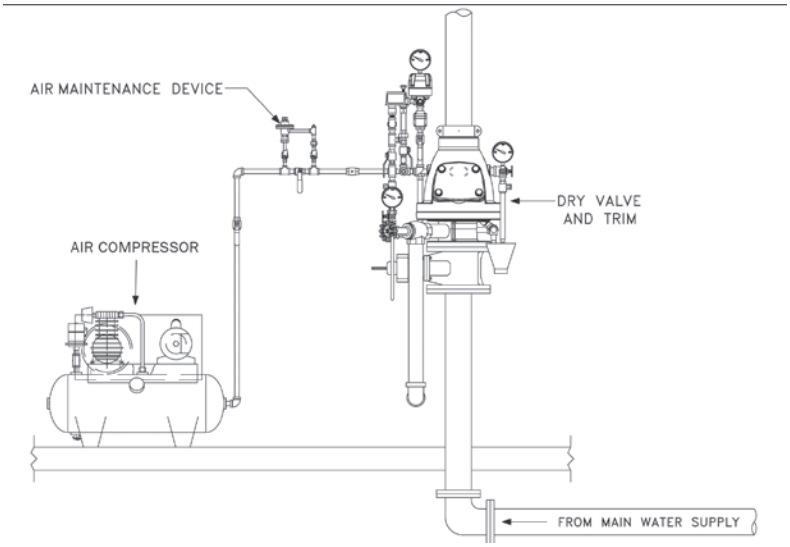

Figure 2 Diagram of a typical dry-pipe service entrance

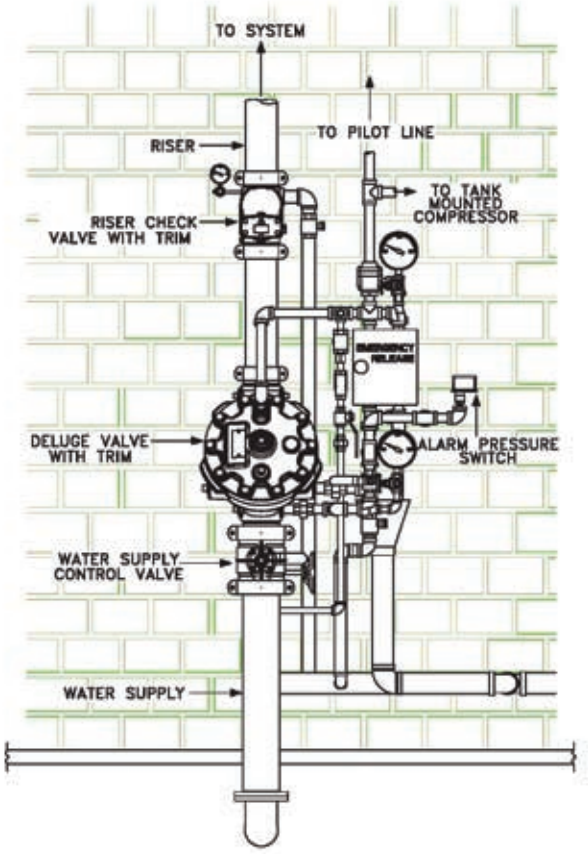

Figure 3 Diagram of a typical preaction service entrance

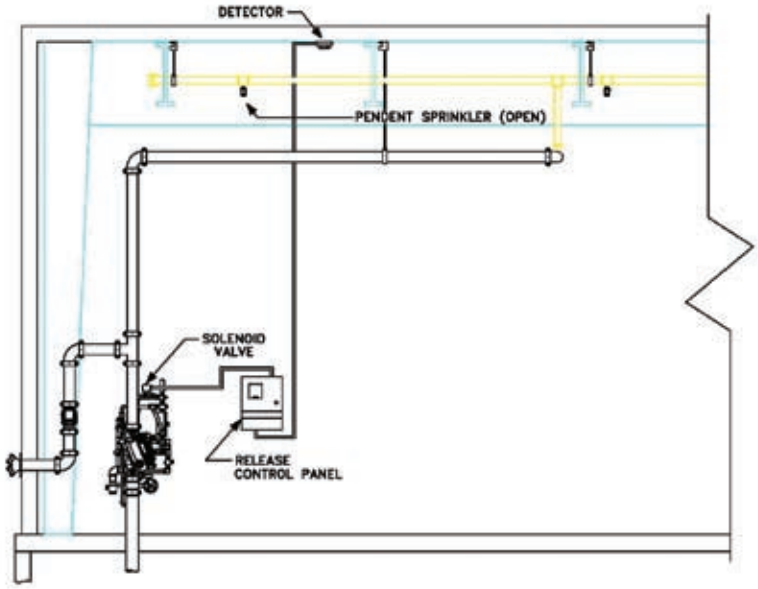

Figure 4 Diagram of a typical deluge service entrance

for large systems), the system can provide a local alarm even when electric power is lost.

Pros
- Simple and reliable system
- Lowest installation expense compared to other types
- Minimal maintenance costs
- Easily modified for renovations
- Short-term downtime following a fire

Cons
- Water damage costs
- Unsuitable for subfreezing environments
- Not suitable for grease fires

DRY PIPE SPRINKLER SYSTEMS

The dry pipe sprinkler system (Figure 2) is similar to the wet pipe system, but the system piping from the dry pipe valve to the automatic sprinklers is filled with pressurized air or nitrogen.

Dry pipe systems are ideal for areas that may experience freezing temperatures; however, there is a time delay between operation of the valves and water reaching the open sprinklers. This occurs because the air pressure must be lost from the system to trip the valve, so water must travel through the piping first and then to the network of sprinklers. Thus, sensitive areas such as residences, sleeping areas, critical computer data or network areas, etc. should be protected with another type of system. Consequently, NFPA 13: *Standard for the Installation of Sprinkler Systems* has certain limitations on system volume, water delivery time, installation of quick-opening devices, use of more conservative C factors for hydraulically calculated systems, and large design areas.

Lower air pressure is capable of keeping the valve shut against the higher water pressure due to a differential on the surface area of the clapper, where the pressures are applied. The delta is created through the clapper assembly of the dry valve itself. The clapper is closed, creating a positive mechanical seal.

Pros
- Ideal for freezing areas
- A safe system regarding potable water

Cons
- More complex system
- Additional costs for air compressor, piping, valves, and trim
- Longer lag time for the water to reach the fire
- Uses expensive dry pendent sprinklers

PREACTION SYSTEMS

A preaction system (Figure 3) uses closed automatic sprinklers connected to a piping system that contains air or nitrogen that may or may not be pressurized. A supplemental detection system is installed in the same area as the sprinklers. Various types of detection systems may be used, including smoke and heat detection. The basic components of a preaction system include a deluge valve with deluge trim. The associated release trims are unique to each specific type of preaction system.

Preaction systems typically are utilized where it is desirable to delay the introduction of water into the system piping until appropriate signals are received from the detection system and/or the supervised

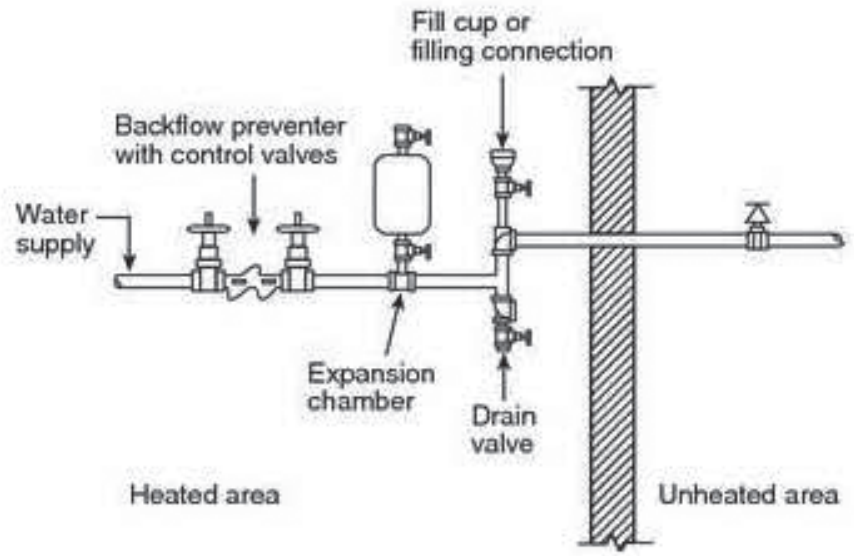

Figure 5 Diagram of a typical antifreeze system

piping. Exactly which signals and how many signals must be received before the valve opens is a function of the type of preaction system and the associated detection.

Preaction systems also are used in areas where a common wet pipe or dry pipe sprinkler system would present a greater potential of facility damage in the unlikely event of unintentional water discharge. Examples of this include computer rooms, telecommunications facilities, museums, libraries, and coolers and freezers.

Pros
- A time delay before sprinklers operate to protect sensitive areas
- Closed sprinklers
- Air-filled piping to prevent against leakage

Cons
- Additional costs for air compressor, piping, valves, and trim
- Longer lag time for the water to reach the fire
- Uses expensive dry pendent sprinklers
- Modification difficulties

DELUGE SYSTEMS

In a deluge system (Figure 4), the pipe system is empty until the deluge valve operates to dispense pressurized water from open nozzles or sprinklers. Deluge systems are more complex than wet pipe and dry pipe systems because they contain more parts and equipment.

The deluge valve is activated by the operation of a fire detection system installed in the same area as the sprinklers. A variety of types of detection systems may be used, including smoke, heat, ultraviolet, or infrared detection. The deluge system can be activated by a hydraulic, pneumatic, electric, or manual release system or any combination of these release systems, but in all cases the deluge valve itself is activated hydraulically. When the detection device is activated, the deluge valve is tripped and water flows into the piping system, discharging through all spray nozzles or sprinklers simultaneously.

Deluge systems are used where conditions of occupancy or special hazards require quick application of large quantities of water. These systems are used to create a buffer zone in high-hazard areas or in areas where fire may spread rapidly, and they also can be used to cool surfaces to prevent deformation or structural collapse or to protect tanks, process lines, or transformers against explosion. Other examples include storage or process areas containing substances having a low flash point, tanks containing combustible solutions, equipment pits, and product-handling systems. When designing a deluge system, an effort should be made to acquire specific information regarding the hazard to be protected.

Deluge systems are required to be hydraulically calculated. Since all sprinklers are open, every sprinkler on the system discharges water simultaneously when the deluge valve operates. The system's area of operation is easy to determine: It is the entire area protected by the deluge system. NFPA 13 discusses the procedures for calculating the hydraulic demand of the sprinkler system and verifying whether the available water supply will meet the requirements.

Pros
- A time delay before sprinklers operate to protect sensitive areas
- Open sprinklers providing a deluge of water
- Protects high-hazard areas

Cons
- Extensive water damage due to the open heads
- Additional costs for piping, valves, and trim
- Longer lag time for the water to reach the fire
- Modification difficulties

ANTIFREEZE SYSTEMS

An antifreeze system (Figure 5) is a wet pipe sprinkler system employing automatic sprinklers that are attached to a piping system containing an antifreeze solution and connected to a water supply. The antifreeze solution is discharged, followed by water, immediately upon the operation of sprinklers opened by heat from a fire. Antifreeze systems are normally a subsystem of

a wet pipe sprinkler system and are used to protect small areas that could freeze.

An antifreeze system is a wet system filled with a glycol-based water mixture. Ethylene glycol, the main ingredient of all major antifreeze brands, is poisonous, and it has a sweet smell and taste that is attractive to children and pets. Drinking ethylene glycol will result in depression followed by heart and breathing difficulty, kidney failure, brain damage, and even death. Used antifreeze also may contain metals such as copper, zinc, and lead. Thus, all antifreeze, new and used, must be safely stored to avoid tragic consequences.

A backflow preventer is required to protect the potable water supply from the water/glycol mixture. Due to the costs associated with the glycol, large systems typically incorporate dry pipe sprinkler systems. Previous editions of NFPA 13 limited antifreeze systems to a maximum of 40 gallons, but new versions of the standard have deleted this limitation.

It's critical to maintain the proper concentration of the antifreeze solution. A pressure variation or temperature fluctuation can change the concentration if more water has flowed into the system or less water has flowed out of the system.

Pros

- Protects small areas from freezing
- No time delay
- No air compressor

Cons

- Additional costs for glycol and backflow preventer
- Higher maintenance cost
- Toxicity and potential for contamination of potable water supply PSD

RESOURCES

NFPA 13: *Standard for the Installation of Sprinkler Systems,* 2007

NFPA 25: *Standard for the Inspection, Testing, and Maintenance of Water-based Fire Protection Systems,* 2008

James Stenqvist, CPD, LEED AP, is a project engineer with Diversified Technology Consultants in North Haven, Conn. For more information or to comment on this article, e-mail **articles@psdmagazine.org.** This article is meant to provide some basic guidelines. Always check all relevant codes and resources for a particular project.

CHECKLIST FOR WATER-BASED FIRE PROTECTION SYSTEMS

Wet System Components

- ❒ Check valves: Vertical or horizontal
- ❒ Relief valves
- ❒ Gauges/connections
- ❒ Main drain
- ❒ Retard chamber

Dry System Components

- ❒ Auxiliary drains
- ❒ Protected from freezing and mechanical injury
- ❒ Valve rooms heated and lighted
- ❒ High water level protection
- ❒ Low differential dry valve
- ❒ High water level device
- ❒ Quick-opening devices
- ❒ Anti-flooding device
- ❒ Air pressure and supply
- ❒ Inspector's test connection

Preaction System Components

- ❒ Deluge valve with trim
- ❒ Water supply control valve
- ❒ Alarm pressure switch
- ❒ Air compressor
- ❒ Check valve

Release Devices

- ❒ Thermostatic (fixed temperature/rate of temperature rise)
- ❒ Manual Automatic sprinklers
- ❒ Heat-responsive devices
- ❒ Release control panel

Deluge System Components

- ❒ Auxiliary drains

Release Devices

- ❒ Thermostatic (fixed temperature/rate of temperature rise)
- ❒ Manual
- ❒ Automatic sprinklers
- ❒ Heat-responsive devices
- ❒ Release control panel

Antifreeze Systems Components

- ❒ Backflow preventer
- ❒ Expansion chamber
- ❒ Fill cup
- ❒ Drain valve
- ❒ Accessories
- ❒ Pressure gauges
- ❒ Water motor alarms
- ❒ Check valves
- ❒ Alarm pressure switches
- ❒ Water-flow indicator

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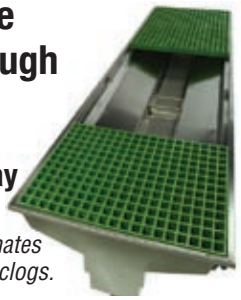

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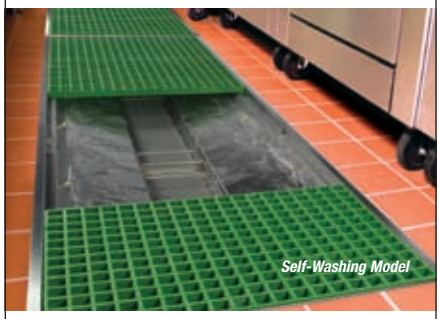

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