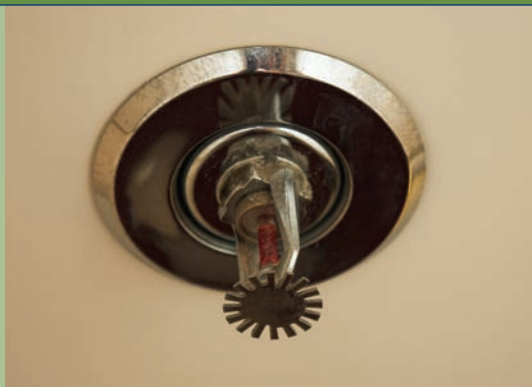
Automatic Sprinkler System Basics

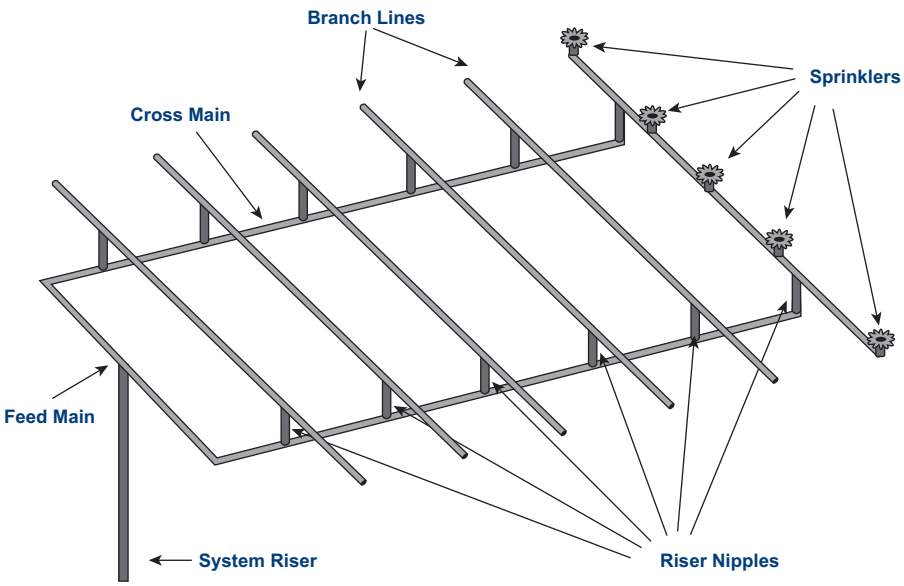
from Liberty Mutual **Property**



Sprinkler systems are the most widely used and reliable automatic source of fire protection available. National Fire Protection Association (NFPA) statistics show that human error and system impairments significantly reduce the reliability of these automatic systems. Learning the basic components of your sprinkler system and how it operates will help you effectively implement human element programs, policies and procedures to ensure its reliability.

NFPA 13, *The Standard for the Installation of Sprinkler Systems*, defines a sprinkler system as a combination of underground and overhead piping connected to an automatic water supply and installed throughout a building. Sprinkler systems can detect fire, transmit an alarm and control or suppress a fire. In most systems, individual sprinklers are activated by the heat of a fire and discharge water where they can effectively protect both the structure and its contents.

Figure 1.
System Piping and Sprinklers



THE FOUR BASIC COMPONENTS OF A SPRINKLER SYSTEM

Sprinklers: Devices that automatically discharge water over a specified area. There are two main types of sprinklers. Closed sprinklers have a heat activated element made of either a glass bulb or a fusible metal link that bursts or melts at a specified temperature. Open sprinkers do not have this heat activated element and will discharge water as soon as it is available to the sprinkler system. Open systems require a separate fire detection system to release the water into the system piping.

System piping (Figure 1): Consists of the following pipes:

- **System riser:** A vertical supply pipe located between the water supply and feed mains. The riser usually contains a control valve to regulate the water supply, a water-flow alarm device and a main drain valve.
- **Cross-mains:** Supply water to the branch lines.
- **Branch lines:** Supply water to the sprinklers.

Supply piping: Underground water supply piping that feeds the risers.

Valves: Devices that control the flow of water through a pipe. Indicating valves have components that show externally


Post indicator valve closed


Outside screw and yoke

Post indicator valve open

whether the valves are open or shut. A common example is an outside screw & yoke (OS&Y) control valve or a post indicating valve (PIV).

TYPES OF AUTOMATIC SPRINKLER SYSTEMS

There are five basic sprinkler system types. Each system has distinctive operating characteristics that should be addressed by the end user.

Wet sprinkler system: The piping in a wet system is filled with pressurized water. Closed sprinklers open when activated by heat and immediately discharge water.

Use: Wet sprinkler systems are the most common type of system. They should not be used in areas where the temperature may fall below 40°F.

Dry sprinkler system: The piping in a dry system is filled with pressurized air or nitrogen, instead of water. Once enough heat is generated to activate one or more sprinklers, the air is released from the system through the sprinklers. At a predetermined pressure, a dry pipe valve automatically opens and releases water to the open sprinklers. There is a nominal delay between the opening of the dry pipe valve and the water discharge from the sprinklers, as the air within the sprinkler piping is released.

Use: Dry systems are used to protect areas subject to freezing, such as unheated warehouses, loading docks and attic spaces.

Preaction sprinkler system: Similar to a dry system, the piping in a preaction system does not contain water and may or may not be filled with pressurized air. Water from the supply piping is held back by a preaction valve and is released to the system piping when the fire detection system and/or sprinklers (depending on the type of preaction system) are activated. The three types of preaction systems are listed below.

Single interlock preaction system:

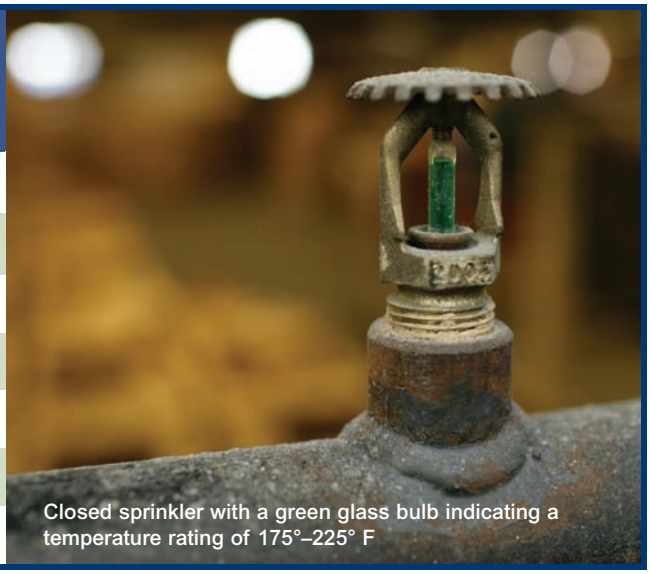
Use: Single interlock preaction systems are used to protect high-value electronic equipment in areas such as computer rooms.

Double interlock system:

Use: Double interlock preaction systems are used to protect freezers where the chance of accidental water discharge must be minimized.

Figure 2. Temperature Ratings

Maximum Ceiling Temperature (°F)	Sprinkler Temperature Rating (°F)	Sprinkler Frame Color Code	Glass Bulb Color Code
100	135 – 170	Uncolored or Black	Orange or Red
150	175 – 225	White	Yellow or Green
225	250 – 300	Blue	Blue
300	325 – 375	Red	Purple
375	400 – 475	Green	Black
475	500 – 575	Orange	Black
625	650	Orange	Black


Closed sprinkler with a green glass bulb indicating a temperature rating of 175°–225° F

Non-interlocked preaction system:

Use: Non-interlocked preaction systems are used to protect unheated warehouses or small airplane hangars.

Deluge system: Uses open sprinklers to deliver a large quantity of water over a specified area in a short period of time. A deluge valve is activated by a fire detection system installed in the same area as the sprinklers. When the deluge valve opens, water flows into the system and discharges from all the attached sprinklers in the system.

Use: Deluge systems are used to protect flammable liquid storage, lumberyards, large airplane hangars and electrical transformers.

Antifreeze sprinkler system: This is a wet system that contains an antifreeze solution in the piping. When the sprinklers are activated, the antifreeze solution is discharged, followed by water from the supply piping. The antifreeze helps prevent the system piping from freezing.

Use: Antifreeze systems are used in small-unheated areas.

AUTOMATIC SPRINKLER DESIGN AND TEMPERATURE RATINGS

Automatic sprinkler systems are available in a variety of designs to accommodate a diverse range of occupancies and storage types. In occupancies where aesthetics are important, sprinklers can be hidden by a manufacturer installed decorative plate. These plates are designed to fall off first, allowing sprinklers to operate in the event of a fire. Sprinklers can have special coatings and protective finishes applied by the manufacturer for decorative appeal or for use in corrosive and other harsh environments. However, sprinklers and decorative plates should not be painted or altered once received from the manufacturer.

Closed sprinklers have various temperature ratings and designs, based on normal air temperatures and hazardous elements within their occupancy. The metal frame or glass bulb of a sprinkler can be color-coded to indicate its specific temperature rating. Refer to Figure 2 for a guide to temperature ratings.

SPRINKLER SIZE AND RESPONSE TIME

The K-factor is the mathematical constant established by the manufacturer that relates the flow of water that can be expected from a sprinkler at a given pressure. The K-factor increases as the orifice size of the sprinkler increases. The K-factor for a standard 1/2 inch sprinkler is 5.6. Refer to Figure 3 for other K-factors.

NFPA 13 states that larger K-factor sprinklers should be used to protect greater fire loads, since they are more effective in suppressing fires in more demanding conditions.

Early suppression fast response (ESFR) sprinklers are used to protect various occupancies according to the Underwriters Laboratory (UL) listing. The K-factor for the ESFR sprinkler can range from 11.2 to 25.2. This sprinkler is designed to protect rack storage of various commodities and heights without the need for in-rack sprinklers.

Use caution when installing ESFR sprinklers because they cannot be obstructed by bottom chords, bridge strappings, electrical conduit, unit heaters or other building components. Contact your Liberty Mutual Property loss prevention consultant if you plan to install an ESFR system. He or she can help assure you that the sprinklers are installed per NFPA standards through a plan review process and an installation inspection. See our Risk Management Guide, *Specifications and Review Process* for more information.

Figure 3. K-factor and Sprinkler Orifice Relationship

Nominal K-Factor	Nominal Sprinkler Orifice Sizes	Percent of Nominal K-5.6 Discharge	Thread Type
1.4	1/4”	25	1/2”
1.9	5/16”	33.3	1/2”
2.8	3/8”	50	1/2”
4.2	7/16”	75	1/2”
5.6	1/2”	100	1/2”
8.0	17/32”	140	3/4 or 1/2”
11.2	5/8”	200	1/2 or 3/4”
14.0	3/4”	250	3/4”
16.8		300	3/4”
19.6		350	1”
22.4		400	1”
25.2		450	1”
28.0		500	1”

PROTECTION RECOMMENDATIONS

There are many varieties of sprinkler systems and even more types of sprinklers. It is important to match your sprinkler system with the hazard and occupancy being protected.

Testing and maintenance procedures are required for all fire protection equipment. We recommend main drain and alarm testing on a regular basis per NFPA 25, *Inspection, Testing and Maintenance of Water Based Fire Protection Systems.* Please refer to our Risk Management Guides, *Wet Pipe Systems, Dry Pipe Systems* and *Impairment Procedures* for more details on testing, maintenance and impairment handling procedures for these systems. These procedures are crucial to maintaining your sprinkler system's reliability.

References

NFPA 13, *Installation of Sprinkler Systems,* 2007 Edition

NFPA 25, *Inspection, Testing and Maintenance of Water Based Fire Protection Systems,* 2008 Edition

NFPA Fire Protection Handbook. Nineteenth Edition

For more Risk Management Guides, go to www.libertymutualproperty.com/resources.

- PE1003 ☐ *Hurricane & Tropical Storm Catastrophe Action Plan & Checklists*
- PE1004 ☐ *Minimizing Hot Work Fires*
- PE1005 ☐ *Human Element Programs*
- PE1012 ☐ *Wet Pipe Systems*
- PE1013 ☐ *Dry Pipe Sprinkler Systems*
- PE1015 ☐ *Fire Pumps*
- PE1021 ☐ *Keeping Sprinklers in Service*
- PE1022 ☐ *Sprinkler Plan Reviews*
- PE1023 ☐ *Transverse Flue Space*
- PE1025 ☐ *Flammable and Combustible Liquids*
- PE1026 ☐ *Flood Exposures*
- PE1027 ☐ *Maintaining Fire Doors*
- PE1028 ☐ *Avoiding Sprinkler Damage for the Hospitality Industry*
- PE1029 ☐ *Winter Threats*
- PE1030 ☐ *Protection for Large Dip Tanks*
- PE1031 ☐ *Idle Pallet Storage*
- PE1032 ☐ *HID Lighting*
- PE1033 ☐ *Spiral Coolers*
- PE1034 ☐ *Ammonia Refrigeration*
- PE1035 ☐ *Specification and Review Process*
- PE1036 ☐ *Industrial Oil Cookers*
- PE1037 ☐ *Freezer and Cooler Hazards*
- PE1038 ☐ *Minimizing Damage from Hail*
- PE1039 ☐ *Risk Management Food Kit*
- PE1040 ☐ *Storage Basics*
- PE1041 ☐ *Automatic Sprinkler System Basics*
- PE1042 ☐ *Roof Systems*
- PE3001 ☐ *Impairment Procedures*

CONTACT US

For more information on our Risk Management Guides, contact us at:

Liberty Mutual

Liberty Mutual **Property**

20 Riverside Road
Weston, MA 02493

TEL: 781-891-0230
EMAIL: propertyengineering@libertymutual.com

www.libertymutualproperty.com

PE1041 10/07