How Fire Sprinkler Systems Operate

Water represents the ideal extinguishing agent for most fires. Fire sprinklers utilize water by direct application onto flames and heat. This action cools the combustion process and prevents ignition of adjacent combustibles.

Sprinkler systems are a series of water pipes which are supplied by a reliable water supply. At selected intervals along these pipes are independent, heat activated valves known as sprinkler heads. It is the sprinkler head which is responsible for water distribution onto the fire. Most sprinkler systems also include an alarm to alert occupants when a fire occurs.

During the incipient fire stage, heat output is relatively low and unable to cause sprinkler operation. As the fire intensity increases, however, the sprinkler's sensing elements become exposed to elevated temperatures and they begin to deform. Assuming temperatures remain high, as they would during an increasing fire, the element will fatigue after an approximate 30 second to 4 minute period. This will release the sprinkler's seals allowing water to discharge onto the fire. In most situations less than 2 sprinklers are needed to suppress the fire. In fast growing fire scenarios such as a flammable liquid spill, up to 12 sprinklers may be required for control.

Additional actions may occur when sprinkler activation happens. These include initiation of building and/or fire department alarms, operation of supplemental water supply systems, shutdown of selected electrical and mechanical equipment closing of fire doors and dampers, and suspension of processes.

Fire Sprinkler Head Components

The sprinkler is the spray nozzle which distributes water over a defined fire hazard area. Each sprinkler operates by actuation of its own temperature linkage. The typical sprinkler consists of a frame, thermal operated linkage, cap, orifice, and deflector. Styles of each component may vary but the basic principles of each remain the same. ~~Click here to view sprinkler head styles.~~

• Frame - The frame provides the main structural component which holds the sprinkler together. The water supply pipe connects to the sprinkler at the base of the frame. The frame holds the thermal linkage and cap in place, and supports the deflector during discharge. Frame styles include standard and low profile, flush, and concealed mount. Some frames are designed for extended spray coverage, beyond the range of normal sprinklers. Standard finishes include brass, chrome, black, and white. Custom finishes are available for aesthetically sensitive spaces. Special coatings are available for areas subject to high corrosive effect. Selection of a specific frame style is dependent on the size and type of area to be covered, anticipated hazard, visual impact features, and atmospheric conditions.

• Thermal linkage - The thermal linkage is the component which controls water release. Under normal conditions the linkage holds the cap in place and prevents water flow, however, as the link is exposed to heat it weakens and releases the cap. Common linkage styles include soldered metal levers, frangible glass bulbs, and solder pellets. Each link style is equally dependable. Upon reaching the desired operating temperature, an approximate 30 second to 4 minute time lag will follow. This lag is the time required for linkage fatigue and is largely controlled by the link materials and mass. Standard responding sprinklers operate closer to the 3-4 minute mark while quick response (QR) sprinklers operate in significantly shorter periods. Selection of a sprinkler response characteristic is dependent upon the existing risk, acceptable loss level and desired response action.

• Cap - The cap provides the water tight seal which is located over the sprinkler orifice. This component is held in place by the thermal linkage. Operation of the linkage causes the cap to fall from position and permit water flow. Caps are constructed solely of metal or a metal with a teflon disk.

• Orifice - The machined opening at the base of the sprinkler frame is the orifice. It is from this opening which extinguishing water flows. Most orifice openings are 1/2 inch diameter with smaller bores available for residential applications and larger openings for higher hazards.

• Deflector - The deflector is mounted on the frame opposite the orifice. The purpose of this component is to break up the water stream discharging from the orifice into a more efficient extinguishing pattern. Deflector styles determine how the sprinkler is mounted, by the angle of their tines. Common sprinkler mounting styles are upright (mounted above the pipe), pendent (mounted below the pipe, i.e. under ceilings), and sidewall sprinklers which discharge water in a lateral position from a wall. The sprinkler must be mounted as designed to ensure proper action. Selection of a particular style is often dependent upon physical building constraints.

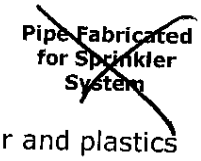
Fire Sprinkler System Water Source

All sprinkler systems require a reliable water source. In urban areas, a piped public service is the most common supply, while rural areas generally utilize private tanks, reservoirs, lakes, or rivers. Where a high degree of reliability is desired, or a single source is undependable, multiple supplies may be utilized.

Basic Fire Sprinkler Water Source Criteria Include:

• The source must be available at all times - Fires can happen at any time and therefore, the water supply must be in a constant state of readiness. Supplies must be evaluated for resistance to pipe failure, pressure loss, droughts, and other issues which may impact availability.
• The system must supply adequate sprinkler supply and pressure - A sprinkler system will create a hydraulic demand, in terms of flow and pressure, on the water supply. The supply must be capable of meeting this demand. Otherwise, supplemental components such as a fire pump or standby tank must be added to the system.
• The supply must provide water for the anticipated fire duration - Depending on the fire hazard, suppression may take several minutes to over an hour. The selected source must be capable of providing sprinklers with water until suppression has been achieved.
• The system must provide water for fire department hoses operating in tandem with the sprinkler system.
Most fire department procedures involve the use of fire attack hoses to supplement sprinklers. The water supply must be capable of handling this additional demand without adverse impact on sprinkler performance.

Selection of Fire Sprinkler Pipe Materials



Sprinkler water is transported to fire via a system of fixed pipes and fittings. Piping material options include various steel alloys, copper, and fire resistant plastics. Steel is the traditional material with copper and plastics utilized in many sensitive applications.

Primary considerations for selection of pipe materials include:

• Ease of installation - The easier the material is installed, the less disruption is imposed on the institution's operations and mission. The ability to install a system with the least amount of disturbance is an important consideration, especially in sprinkler retrofit applications where building use will continue during construction.
• Cost of material versus cost of protected area - Piping typically represents the greatest single cost item in a sprinkler system. Often there is a temptation to reduce costs by utilizing less expensive piping materials which may be perfectly acceptable in certain instances, i.e. office or commercial environs. However, in museum applications where the value of contents may be far beyond sprinkler costs, appropriateness of the piping should be the deciding factor.
• Contractor familiarity with materials - A mistake to be avoided is one in which the contractor and pipe materials have been selected, only to find out that the contractor is inexperienced with the pipe. This can lead to installation difficulties, added expense, and increased failure potential. A contractor must demonstrate familiarity with the desired material before selection.
• Prefabrication requirements or other installation constraints - In some instances requirements may be imposed to limit the amount of work time in the space. This will often require extensive prefabrication work outside of the work area. Some

materials are easily adapted to prefabrication.
• Material cleanliness - Some pipe materials are cleaner to install than others. Various materials are also resistant to accumulation in the system water. Cleanliness of installation and discharge should be a consideration.
• Labor requirements - Some pipe materials are heavier or more cumbersome to work with than others. Consequently additional workers are needed to install pipes which can add to installation costs. If the number of construction workers allowed into the building is a factor, lighter materials may be beneficial.

Major Fire Sprinkler System Components

The basic components of a fire sprinkler system are the sprinklers, system piping and a dependable water source. Most systems also require an alarm and system control valves.

Other major sprinkler system components include:

• Control valves - A sprinkler system must be capable of shut down after the fire has been controlled, and for periodic maintenance and modification. Control valves provide this function. In the simplest system a single shut-off valve may be located at the point where the water supply enters the building. In larger buildings the sprinkler system may consist of multiple zones with a control valve for each. Control valves should be located in readily identified locations to assist responding emergency personnel.
• Alarms - Alarms alert building occupants and emergency forces when a sprinkler water flow occurs. The simplest alarms are water driven gongs supplied by the sprinkler system. Electrical flow and pressure switches, connected to a building fire alarm system, are more common in large buildings. Alarms are also provided to alert building management when a sprinkler valve is closed.
• Drain and test connections - Most sprinkler systems have provisions to drain pipes during system maintenance. Drains should be properly installed to remove all water from the sprinkler system, and prevent water from leakage onto protected spaces, when piping service is necessary. It is advisable to install drains at a remote location from the supply, thereby permitting effective system flushing to remove debris. Test connections are usually provided to simulate the flow of a sprinkler flow, thereby verifying the working condition of alarms. Test connections should be operated every 6 months.

• Specialty valves - Dry-pipe and preaction sprinkler systems require complex, special control valves that are designed to hold water from the system piping until needed. These control valves also include air pressure maintenance equipment and emergency operation/release systems.
• Fire hose connections - Fire fighters will often supplement sprinkler systems with hoses. Firefighting tasks are enhanced by installing hose connections to sprinkler system piping. The additional water demand imposed by these hoses must be factored into the overall sprinkler design in order to prevent adverse system performance.
• Backflow preventer - The normal backflow requirement for an automatic fire sprinkler system is a double check valve assembly. When chemical additives are a part of the sprinkler system, such as anti-freeze, the backflow protection is typically by a reduced pressure principle backflow preventer. A backflow preventer prevents the backflow of polluted water into the potable water supply.
• Manifold - Manifolds are used to run direct water lines to each plumbing fixture. The manifold system saves installers time by eliminating the number of connections required in the system. Pressure fluctuations are also reduced.

Design & Build Fire Sprinkler Systems

The companies of our Fire Protection Group have the proven ability to develop, layout and install turn-key fire sprinkler systems, on time and on budget. We offer the unique combination of managerial and technical expertise essential to complete any new or retrofit project.

When we are part of the design team, you'll get more than just skilled professionals with a comprehensive knowledge of codes and fire sprinkler system requirements, you'll also receive the valuable benefit of a dedicated work ethic and more than seventy years of industry leadership. As a result of our qualifications, the process of "Concept to Final Product" moves smoothly, so the owner or tenant is in the building faster and at lower cost.

Count on us for the accurate preparation of design concepts, detailed specifications, installation plans, and budgetary criteria, as well as the ability to assist with necessary feasibility planning. Additionally, we are there to make value engineering recommendations that will help create a project of the highest quality with effective, efficient use of capital.