

SPRINKLER SYSTEMS
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INTRODUCTION

Fire protection systems offer one of the most effective means known for reducing fire loss. Many of today's fire protection systems are able to report, contain, and extinguish some smaller fires. The basic types of fire protection systems include:

- Sprinkler systems NFPA 13, 13A, 13D, 13R
- Standpipe systems
- Fixed extinguishing systems
- Early warning fire detection systems

Possible sprinkler systems firefighters may encounter include: wet-pipe, dry-pipe, pre-action, and deluge systems. All of these systems will expel water to control a fire. Standpipe systems are typically void of sprinkler heads. Rather, they are pipe systems, which supply water to either lightweight linen fire hose or outlets for fire hose. Fixed extinguishing systems are characterized by protection systems that have a fixed or limited supply of expellant. Most chemical protection systems and some sprinkler systems are fixed extinguishing systems. Alarm systems are constructed in conjunction with one of the three previous systems. It is important to note that alarms are not a substitute for the extinguishing systems.

Protection systems may be a composite of two or more of the extinguishing types or they may be constructed from a single type. Some systems may combine a wet pipe sprinkler system with a wet pipe standpipe system (i.e., linen extinguishing hoses). Each system must be maintained and all the components of a particular system should be listed by a nationally recognized testing facility, (i.e., Underwriters Laboratories). Each system must conform to well-established designed testing standards. Each system must also be properly designed to fit the needs of the building or materials within it. For example, areas where the possibility of an electrical fire is the major concern, a fixed extinguishing system using a chemical expellant may be most appropriate to contain the fire.

Firefighters need to have an understanding of each of the fire protection systems. They should be able to state the differences between the systems, how to operate them, and how to test them. Firefighters should also be able to demonstrate the use and testing of fire protection systems. This knowledge will benefit not only in fire containment, but in life safety as well. Systems that are properly maintained and operated have the propensity for saving many lives.

Objectives

- Identify the basic operating principles of fire protection systems including:
 - a. Wet and dry standpipes.
 - b. Carbon dioxide and dry chemical systems.

- c. Foam and Halon systems.
 - d. Alarm systems associated with fire protection systems.
- Identify the methods of supplying water to different types of wet and dry standpipe systems.
- Describe the major components of modern water systems, which would include:
 - a. Sources of supply (lakes, streams, reservoirs, tanks, ground water)
 - b. Distribution systems (pump, gravity, combination)
 - c. Primary feeders
 - d. Secondary feeders
 - e. Distributors
 - f. Water main valves
 - g. Hydrants
- State the percentage of fires extinguished or held in check by sprinkler systems, the percentage of fires extinguished by a single head, and the relationship of sprinklers and life safety.
- Describe the reasons why sprinkler systems occasionally fail, including:
 - a. Inadequate water supplies
 - b. Premature closing of control valves
 - c. Poor or improper maintenance
 - d. Improper sprinkler system design
 - e. Hazards of the occupancy
 - f. Obstructions to operation
 - g. Only partial protection of the building available
- Describe the sources of water supply for sprinkler systems, which would include:
 - a. Public Water Systems
 - b. Gravity Tanks
 - c. Pressure Tanks
 - d. Pumps
 - e. Fire Department Connections
- Describe the location and appearance of the control and operating valves of a sprinkler system, including:
 - a. Outside Stem and Yoke (OS&Y)
 - b. Post Indicator Valve (PIV)
 - c. Wall Post Indicator Valve (WPIV)
 - d. Post Indicator Valve Assembly (PIVA)

- State the difference between an indicating and a non-indicating valve and describe how to determine if each type is open.
- Describe the operation of alarm valves, including the difference between a hydraulic (mechanical) and an electric water flow alarm system.
- For each type of alarm, describe and demonstrate the location and operation of the alarm test valve and its relationship to the retard chamber.
- Describe and demonstrate the location, operation and draining of velocity drain and ball drop valves (on retard chambers and fire department connections).
- Describe how the direction of water flow through a fire department connection check valve can be determined (i.e., arrows or pivot casting).
- Describe the temperature ratings and associated colors on sprinkler heads.
- Describe the difference between upright and pendant sprinkler heads.
- Describe the different types of sprinkler heads, including:
 - a. Decorative
 - b. Directional
 - c. Flush mounted
 - d. Recessed
 - e. Unspoiler
 - f. Cornice
 - g. Coated
- State the required clearances below sprinkler head deflectors and the possible obstructions to such clearances.
- Describe and demonstrate how to conduct a main drain test on either a wet or dry standpipe sprinkler system.
- Wet pipe testing would include:
 - a. Observation and recording the static pressures on the gauge(s) at the system riser.
 - b. Opening the two (2) inch main drain and recording the pressure drop on the gauge.
 - c. Closing the main drain and comparing readings on the gauge.
- Dry pipe testing would include:
 - a. Differentiating between the air pressure gauge and the water pressure gauge.

- b. Recording the static pressure on the water gauge.
- c. Opening the main drain valve and recording the flow pressures.
- d. Closing the main drain valve slowly.
- Describe the methods of determining the usability of hydrants. Including:
 - a. Type of hydrant for the area served.
 - b. Obstructions.
 - c. Direction of outlets.
 - d. Mechanical damage.
 - e. Condition (rust, corrosion, ungreased outlets).
 - f. Flows when fully opened.
 - g. Clearances.
 - h. Ability to drain.

SPRINKLER SYSTEMS OVERVIEW

Sprinkler systems vary a great deal, dependent upon the occupancy needs. Different systems include wet and dry pipe, pre-action, and deluge sprinkler systems. Recent research has revealed that 96% of all fires in sprinklered buildings were controlled or extinguished by the sprinkler system. Of the 4% that were not controlled, improper maintenance, inadequate water supply, poor design of the protection system, and closed control valves were cited as the cause of the failure. Of the fires controlled or extinguished by sprinkler systems, 35% were contained by a single sprinkler head. This has strong implications regarding life safety. Since sprinkler systems have the ability to extinguish a fire in an early stage, life safety is increased many times. Fatalities, in sprinklered buildings are usually due to injuries that were incurred before the sprinkler heads opened.

Each sprinkler system is unique to its surroundings. They will have various types of sprinkler heads, temperature ratings for sprinkler heads (thermal detectors), alarms, water pressure gauges, control and operating valves, test valves, drain valves, and sources of water supply. Generally however, sprinkler system layouts are similar in construction. The system is attached to a feeder main at its base. The feeder main supplies a vertical pipe, known as the main riser, which typically, has a one-way check valve within it. The main riser then connects to a cluster of valves and branches, including a control valve, alarm valve, main drain connection, and fire department connection. There may also be a test valve within the cluster. The cluster will also have two (2) pressure gauges that identify the water psi before and after the alarm valve. Slick risers are similar to main risers but are marked by an absence of the control valve. In either case, the control valve may be difficult to find. The main riser moves upward from the cluster and branches to cross or feed mains at ceiling level (at each ceiling in structures). The cross-mains feed the branch lines on which the sprinklers are located. The entire series of piping decreases in size as it feeds towards the sprinkler heads.

To facilitate flushing the sprinkler system, each cross-main extends past the last branch line and is capped. To simplify the draining of dry systems after use, all pipes are sloped. All systems have a connection, which is used for inspection tests. This connection is usually attached to the end of the highest and furthest branch away from the main feeder.

Sprinkler System Failures

Sprinkler systems rarely fail to operate. However, there are several reasons for sprinkler system failure, of which the most common is closed control valves at the time of the fire. This single reason accounts for over 35% of all sprinkler system failures and is more the result of human error than failure of the system. In fact, most failures are due to the error of an individual as opposed to the sprinkler. Improper system design, partial protection coverage, poor or improper maintenance, and even premature shut

down of the systems are factors which are directly controlled by people. There are reasons which may not be directly controlled by individuals. These include the hazards of the occupancy, obstructions to operation, and inadequate water supply.

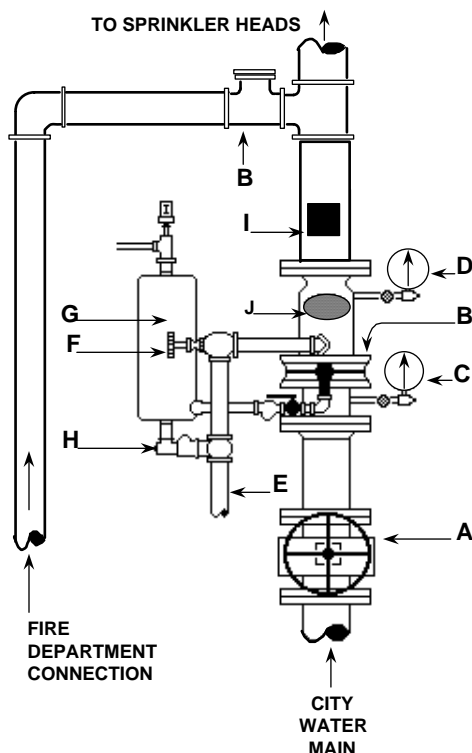
SPRINKLER SYSTEM CONTROLS

Control and Operating Valves

Integral to each sprinkler system is the main control valve. These valves are used to shut off the supply of water when maintenance is required. Control valves must be left open when maintenance is not being performed so that the water supply is not cut off from the system. The control valve is usually located on the main riser directly under the sprinkler alarm valve. It may also be located outside the structure e.g., PIV (post indicator valve). Pre-fire planning should always include the location of this valve when the structure contains a sprinkler system. These valves must be indicating, (i.e., the valve position must be determinable at a glance). Many control valves are hooked up to alarms that will notify a private alarm company if the valve is closed. If the valve is turned off, an alarm is sent directly to the alarm company alerting them to the closure of the valve.

Multi-floored structures may have operating valves on each floor and/or section of floor. These valves are much the same as the main control valve in design and function, except that they will control water flow in a localized area only. They must be indicating and will usually be located at or near the spot where the riser enters the floor. Again, pre-fire planning will be helpful in determining their location.

TYPICAL SPRINKLER SYSTEM



- a. O.S. & Y Valve
- b. Check Valve
- c. Water Supply Pressure Gauge
- d. System Pressure Gauge
- e. Main Drain
- f. System Drain Valve
- g. Retard Chamber
- h. Retard Chamber Drain
- i. Water Flow Alarm. (Electric Sensor Type)
- j. Certification Plate

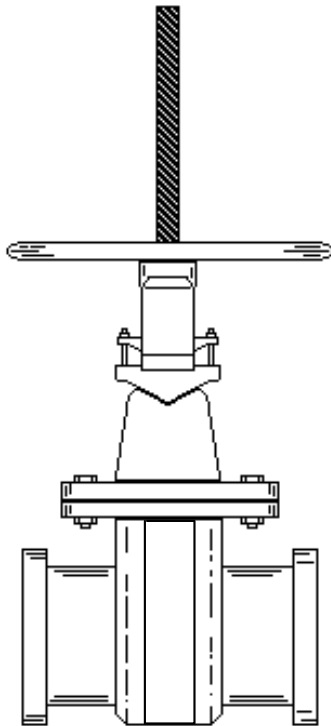
Indicating Valves

These valves are manually operated valves that will indicate whether the valve is open or closed. There are four (4) common types of indicating valves, which include:

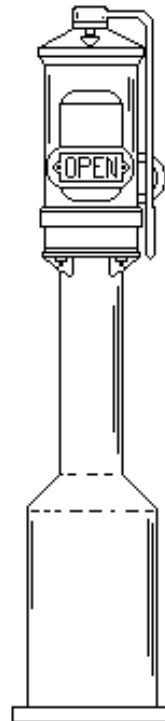
- Outside stem and yoke (OS&Y)
- Post indicator valve (PIV)
- Wall post indicator valve (WPIV)
- Post indicator valve assembly (PIVA)

The OS&Y (outside stem and yoke) valve has a yoke at the side of the riser with a wheel and threaded stem assembly attached to the yoke. When the valve is open, the stem will extend out of the yoke. By turning the wheel clockwise the stem will move into the yoke forcing the valve to close. Turning the wheel counterclockwise will open the valve. The key to the valve position is the status of the threaded stem which is either in (closed) or out (open) of the yoke.

OS & Y VALVE



POST INDICATOR VALVE



The PIV is a hollow metal post that is attached to a valve assembly. The valve stem is located inside the post and is actuated by operating a nut on the top of the post. This type of valve will have a target window, which will read either "OPEN" or "SHUT" depending on the position of the valve. The key to indication is the reading in the target window.

WPIVs (wall post indicator valve) are similar to PIVs with the exception that they are wall mounted or have a valve stem that runs through the wall of the building. The target window and valve-operating nut are located on the outside of the wall. The key to indication is the same as for PIVs.

PIVAs (post indicator valve assembly) are similar to PIVs except that a butterfly valve is used instead of the gate valve used by the PIV, WPIV, and OS&Y valves. The key to indication is the same as for PIVs.

Non-Indicating Valves

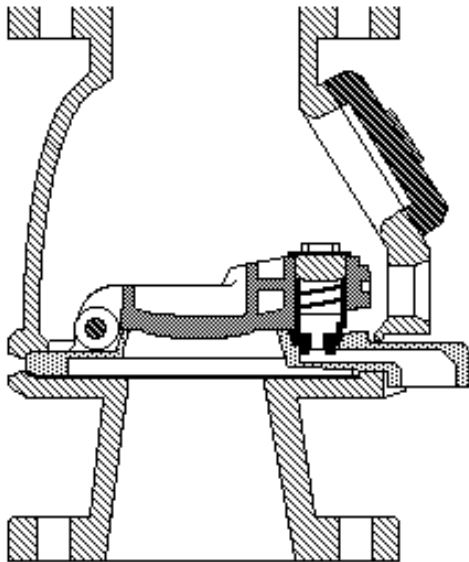
These valves are utilized in the main drain, as test valves, and auxiliary valves. As the name alludes, the position of the valve cannot be determined at a glance. The most common type of non-indicating valve is the globe valve. This valve is very common in plumbing. For example, most outdoor water spigots operate via globe valves. They are not used for controlling valves because there is no way to physically observe whether the valve is open or closed. In your area, the local water district requires the use of non-indicating valves in certain portions of the water system. For this reason firefighters may encounter them while operating sprinkler systems. Firefighters need to be aware of their operation to ensure the system is open properly, since it is not possible to see if the valve is open or closed.

Check Valves (Clapper Valves)

These valves are constructed to allow water flow in one direction and impede it in the other direction. The valve will open on a pivot with water pressure from one direction. Pressure from the other direction will force the valve against the valve seat impeding water travel.

The designed direction of the water flow in the valve will be signified by an arrow, which is cast into the side of the valve. Direction can also be determined by the position of the pivot casting. The casting nut will be located closer to the water entrance than to the water exit from the valve. Typically, these valves will be used as alarm check valves, clapper valves (fire department connections, and dry pipe valves).

CLAPPER VALVE (CUT AWAY VIEW)



Water Flow Alarms (and Retard Chambers)

Sprinkler system water flow alarms are essential to all sprinkler systems. The alarm is usually local in nature, however, some alarms (electric) are sent to a listed alarm company as well. The alarm is used to alert individuals to both the flow of water in the system and the possibility of fire. If it is connected to a private alarm office, the attendant in charge of the office will alert the fire department to the possible hazard in a similar manner to other alarms.

Water flow alarms are operated in one of two ways, either hydraulically (mechanically) or electrically. Mechanical alarms are operated by a water motor, which drives a local alarm bell. The electric alarm is sounded when a valve (paddle) pushes up and contacts a diaphragm, which in turn causes an electric switch to operate the alarm. The valve is pushed under pressure from water flow.

To avoid the possibility of false alarms, several types of alarm delays are available to the sprinkler system. The delay is approximately 30 to 300 seconds and is adjustable in most systems. By law, the delay cannot exceed five minutes (NFPA Standard 13). Mechanical systems (and some electric systems) use a retard system to delay the alarm. Typically these delays are employed in wet pipe systems but some dry pipe systems may also have them. The retard consists of a check valve that opens when the alarm valve opens during water flow (often referred to as a clapper valve). The check valve is attached to a branching pipe, which in turn attaches to a small chamber. The chamber, referred to as the retard chamber, will fill with water when the check valve opens. At the bottom of the chamber is a drain, which is adjusted to allow water to drain out at a specified rate. If the water fills the chamber faster than it can drain out, it will

reach the top of the chamber and activate either the diaphragm (electric) or the water motor (hydraulic) or both if the system is so equipped.

Stacking the Riser

Another alarm check that may be encountered, but that is not necessarily associated with the alarm, is a device, which stacks the riser. This device, known as a Pony pump, is electrically operated and is located on the system side of the alarm check valve. Its basic function is to increase the water pressure in the system by approximately 10%.

There is a constant fluctuation of pressure in the city's water mains dependent upon usage. If a sudden increase in pressure occurs, the check valve could open and initiate the alarm. By stacking the riser, the check valve is forced against the valve seat under pressure and therefore the alarm is not activated if a surge in the line occurs.

Alarm Test Valve

The alarm test valve is usually located on a pipe, which connects between the water supply and the retard chamber. It is used to test the alarm by allowing water to by-pass the alarm check valve and directly enter the retard chamber from the supply source.

Velocity Drains and Bell Drip Valves

These valves are utilized to allow trapped water to drain from the dry pipe sprinkler system when there is no other escape route. They can be found in fire department connections, retard chambers, and/or at low pipe position where water may become trapped. The ball drip valve operates via a chamber with a free ball bearing that is forced against the drain under the pressure of water velocity. When the pressure is no longer present, the ball, acting by gravity, moves away from the drain hole allowing trapped water to escape

SPRINKLER SYSTEM TYPES

Wet Pipe Systems

Wet pipe systems are directly connected to a water source and contain pressurized water within the system at all times. If a sprinkler head fuses, water will immediately discharge from the system. After a specified amount of time an alarm will sound, warning that the possibility of fire exists.

The system is operated in the following manner: When one or more sprinkler heads open, pressurized water is released from the heads as the pressure from the supply source forces water into the system to supply the open sprinklers. Water can also enter through secondary supply sources (fire department connection) to increase the pressure and thus the water flow. When a delay interval has been satisfied (i.e., through a retard chamber, or electronic delay) the alarm will sound. The system can be shut down via the main control valve (i.e., OS&Y, PIV, etc.).

Some wet pipe systems are also equipped with 1-1/2" fire hose outlets (Combined Systems). These hoses are usually constructed out of single jacketed linen and will leak until they swell by absorbing water. In all newer construction or where hose has been replaced, the hose will be single jacket rubber lined. Typically, they are up to 150' in length and have a fog nozzle attached. Wet pipe hoses are designed for use by the building occupants and, therefore, do not necessarily expel water at the same pressure as a Firefighter is used to.

Dry Pipe Sprinklers

In this type of system, pressurized air replaces water above a dry pipe valve. The dry pipe valve keeps water from entering the system until it is needed. Typically, the heads are constructed in the same manner as wet pipe sprinkler heads. These systems are not common in the San Diego area because their major advantage concerns avoiding frozen pipes where the heat is insufficient to maintain water in a liquid state, a problem that does not occur very often in our area.

When a sprinkler head fuses, the air pressure escapes and allows the dry pipe valve to open and replace the air with water. The water will fill an intermediate chamber area where the air pressure access valve and alarm valve are located. It will close the access valve, open the alarm valve and then fill the system, releasing water at the fused heads. The required air pressure is from 15 to 50 psi and is delivered from two (2) possible sources. Air can come from either plant air service or from an air compressor and tank designed exclusively for the sprinkler system. Some dry pipe systems are equipped with alarm delays but they are not a necessity. However, Alarm units are mandatory.

Many dry pipe systems utilize accelerators or exhausters to speed up the flow of water through the system when a sprinkler head is opened. Both systems operate in a similar manner, making use of a second pressurized chamber with a diaphragm between the chamber and the system, which is then attached to the dry pipe valve. When air pressure is reduced in an accelerator system, the diaphragm becomes unbalanced due to the greater air pressure in the second chamber. This causes the dry pipe valve to open. The exhauster quickly removes the air pressure from the second chamber when a decrease in air pressure is sensed in the system, again tripping the dry pipe valve. Any dry pipe systems that have capacity of over 500 gallons of water are required to have an accelerator or exhauster.

Pre-Action Sprinkler Systems

This system is basically a dry pipe system with a couple of changes. It utilizes a deluge type dry pipe valve, pipes that are air pressurized, pre-fire suppression alarm devices, and closed sprinkler heads. This system is rare in San Diego County and is used where water damage must be kept to a minimum. Examples of atmospheres that would warrant a pre-action system are computer rooms or laboratories where water damage could destroy critical experiments.

The key to a pre-action system is the detection system. Even though the pipe is pressurized, a loss of air pressure will not set off the system. Fire detection devices must first detect the presence of fire before water is infused into the system. This prevents accidental discharge of water when a sprinkler head or pipe rupture occurs relieving the air pressure. The detection device also acts as an alarm to warn that water will be forthcoming and of the possibility of fire.

Deluge Sprinkler Systems

These systems are used where material within the structure is extremely susceptible to fire exposure. For example, aircraft hangers, glue factories, and where there is an extreme danger of rapid fire spread.

Deluge systems are similar to pre-action systems with the exception that the sprinkler heads are always open; therefore, the pipes are not pressurized. A deluge valve will open when the detection device signals a fire present. The deluge system could be controlled by fire, heat, smoke detection devices, or may be manually operated. When the deluge valve opens, water is supplied to all of the sprinklers and thus wet down the whole area, not just an isolated area as with pre-action and dry pipe systems. Firefighters may encounter systems where some sprinkler heads are closed while others are open. These systems are considered variations of the deluge system.

SPRINKLER HEADS

Types of Sprinkler Heads

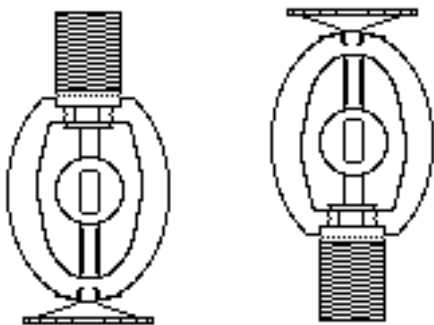
There are many different types of sprinkler heads utilized in fire protection systems. Most are equipped with a thermal detector that keeps the head from releasing water until it is fused or melted by heat. When the thermal detector reacts to the heat, a cap is released from the nozzle of the sprinkler head and water, or air followed by water is released, depending on the type of sprinkler system. It is important to note that some sprinkler heads are permanently open and operate automatically once a fire detection device has perceived the heat and opened the deluge valve (see Deluge Sprinkler Systems). Each sprinkler head is equipped with a deflector, which transforms the water stream released from the nozzle (from 3/16" to 3/4" in diameter) into a spray, which will more efficiently contain the fire.

The four most common types of release mechanisms include:

- Fusible Links
- Soldered Pellets
- Liquid Bulbs
- Quick Response Fusible Links

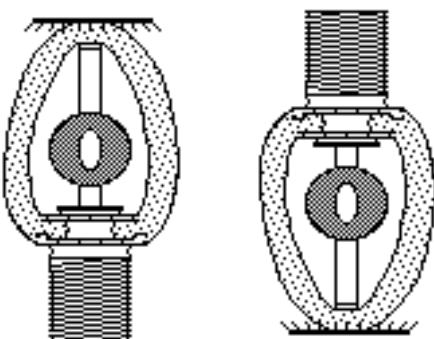
Each type of thermal detector reacts in a similar manner. The heat source will destroy some critical component of the detector, which allows the cap to release from the nozzle.

Fusible Links



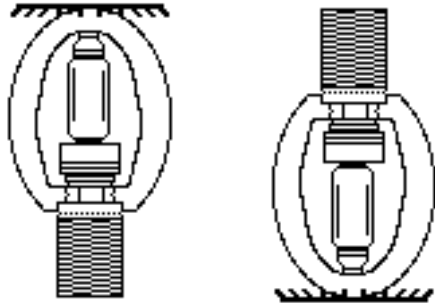
Fusible links incorporate two levers, which are positioned between the nozzle cap and the outer sprinkler head frame to which the deflector is attached. The levers are then attached to each other via a fusible plate. Heat acts upon the plate, fusing it, and therefore destroying support to the levers. Once the link has fused, water (or air) pressure pushes the levers and nozzle cap out of the way.

Soldered Pellet



This type of detector employs a small pellet of solder, which holds a small plunger in place against the nozzle cap. At a predetermined temperature, the pellet will melt and allow the plunger to slide away from the cap, which is then pushed away from the nozzle by water or air pressure.

Liquid Bulb



A small glass bulb is placed between the frame and cap of the sprinkler head. The bulb is partially filled with a liquid, which will expand when heated. The expansion of the liquid will eventually shatter the bulb releasing the nozzle cap. The amount of liquid in the bulb will determine the temperature required to open the head.

Quick Response Links

These are similar to fusible links with a much quicker reaction time. This is facilitated by a fusible link, which has a greater surface area through which it can collect heat. Quick response links are used when life safety is a major concern (i.e., offices).

Specialized Sprinkler Heads

There are a multitude of sprinkler head types, specialized to meet the needs of almost any type of occupancy. Heads are designed for esthetic purposes, directional coverage, automatic shutoff, and anti-corrosiveness.

Esthetic type heads can be: chrome plated or decor (finished or painted), recessed, flush mounted, or unspoiler. Recessed heads are mounted with the deflector flush with the ceiling. A small hole in the ceiling exposes the head to the area of coverage and a finish plate around the hole and head covers exposed piping. The flush mounted head is mounted flush to the ceiling. Under normal conditions, the deflector is flush to the sprinkler nozzle. When activated the deflector extends from the nozzle which opens at the same time. Unspoiler heads are also mounted flush to the ceiling. These heads have a heat reactive cover over the sprinkler head, which hides the head from view. At approximately 135 degrees F the cover will fall off the head. This type of sprinkler head will not usually fuse however, until a temperature of 165 degrees F is obtained.

Directional heads can be made in several different ways. Some have deflectors designed to direct the water spray in a specific direction (i.e., oversized or bent deflectors). Other heads are positioned to come out of a sidewall or from a side angle, to attack the fire from its flank. Still others, such as deluge heads, have adjustable nozzles and deflectors that can be changed based on need. Cornice heads are heads designed for installation under cornices or roof ridges. This type of directional head will create a narrow fan-shaped water pattern.

In areas where corrosion is a factor, sprinkler heads must be coated so they do not corrode and become non-functional. Typically, heads are coated with wax or lead which melts off in heat. These types of sprinklers are found near the waterfront.

Upright and Pendant Sprinkler Heads

Sprinkler heads operate in one of two positions, either upright or pendant (facing downward). The important difference between the two is the type of deflector installed on the unit. Upright heads are designed to discharge water upwards towards a concentric deflector, which redirects the water downward in a hemispherical pattern. Pendant or hanging heads have deflectors, which are curved away from the nozzle. These deflectors create a hemispherical pattern when the water is deflected.

Sprinkler Head Temperature Ratings

Sprinkler heads are constructed to release water at specific temperatures and in most cases are color-coded to denote the temperature range at which they will begin to expel water. The particular rating used in a given structure or area is determined by the anticipated release of heat by a fire in that area and the highest temperature that the sprinkler may endure during non-fire conditions. Firefighters may encounter sprinkler heads without a color-coding as the case may be with decorative and coated heads. Coated heads should be color coded on the frame arms, and though decorative heads are not required to be color coded, some manufacturers use a colored dot on the top of the deflector to signify the temperature rating. The following table taken from IFSTA Essentials, Chapter 16, identifies the temperature ranges and color-coding for sprinkler heads:

Sprinkler Color Codes

<u>Temperature Rating</u>	<u>Frame Color</u>	<u>Temperature Classification</u>
135 to 170	Ordinary	Unpainted*
175 to 225	Intermediate	White or Yellow
250 to 300	High	Blue
325 to 375	Extra High	Red
400 to 475	Very Extra High	Green
500 to 575	Ultra High	Orange

*These heads may also be half black and half painted, or chrome plated.

Sprinkler Head Clearances

As stipulated in the Uniform Fire Code (UFC), the minimum clearance below a sprinkler system will be no less than 18 vertical inches from any head. Obstructions could include false ceilings, over-stacked materials, shelves that are constructed too close to the sprinkler heads, and/or over-stacked shelves.

Coverage

The use made of a building is an essential consideration in designing a sprinkler system that is adequate to protect against the hazards inherent in the type of occupancy. For

the purposes of evaluating hazards, three main classes of occupancy are recognized in the NFPA Sprinkler Standard.

Classification of Occupancies: The three main classifications are:

1. Light Hazard
2. Ordinary Hazard
3. Extra Hazard

Light Hazard Class: Includes occupancies where the quantity and combustibility, or both, of materials is low, and fires with relatively low rates of heat release are expected. Examples are apartments, churches, dwellings, hotels, public buildings, office buildings, and schools.

Ordinary Hazard Class: This class is divided into two groups, mainly because each requires a somewhat different water supply for sprinklers. In general, this class includes ordinary mercantile, and manufacturing, and industrial properties.

Group 1: Covers properties where combustibility is low, the quantity of combustibles is moderate, stockpiles of combustibles do not exceed 8 ft. in height, and fires with moderate rates of heat release are expected. Examples are canneries, laundries, and electronic plants.

Group 2: Includes properties where the quantity and combustibility of contents is moderate, stockpiles do not exceed 12 ft., and fires with moderate rates of heat release are expected. Examples are cereal mills, textile plants, printing and publishing plants, and shoe factories.

Extra Hazard Class: Extra hazard occupancies involve a wide range of variables, which may produce severe fires.

Group 1: Includes occupancies with little or no flammable or combustible liquids. Some examples are die-casting, metal extruding, rubber production operations, sawmills, and upholstering operations using plastic foams.

Group 2: Includes occupancies with moderately substantial amounts of flammable or combustible liquids or where shielding of combustibles is extensive. Some examples are asphalt saturating, flammable liquid spraying, open oil quenching, solvent cleaning, varnish and paint dipping.

The majority of new installations are "calculated" systems. Calculated sprinkler systems are designed with the aid of computers. In all cases, the size of pipes will be smaller in these systems.

SPRINKLER MAIN DRAIN TESTING

Wet Pipe System Testing

Two-inch main drain tests should be conducted at least once a year though quarterly testing is recommended. The inspector conducting the test should perform an alarm test at the same time and keep accurate records of the tests.

NOTE: These tests are performed only by the owner/occupant, private alarm or sprinkler companies, or other qualified person.

Step 1: Observe and record the static pressures on the gauge(s) at the main riser.

Step 2: Open the two-inch main drain fully and record the pressure drops observed on the pressure gauge(s).

Step 3: Close the drain valve and compare the pressure readings with those obtained in Step 1. Significant differences could be the result of a partially open or obstructed supply valve. NOTE - systems employing an alarm check valve may show erroneously high static pressures in the gauge above the valve. Therefore, readings for step 3 should be taken only from the lower gauge.

ANNUAL INSPECTOR'S TEST

Sprinkler systems should also have an "annual inspector's test". This test simulates the flow of (1) sprinkler head with a 1/2" orifice by opening the inspector's test valve. The test insures water in the system as well as testing to see if the local and/or supervised system is operational. Note: This is not a five-year certification test.

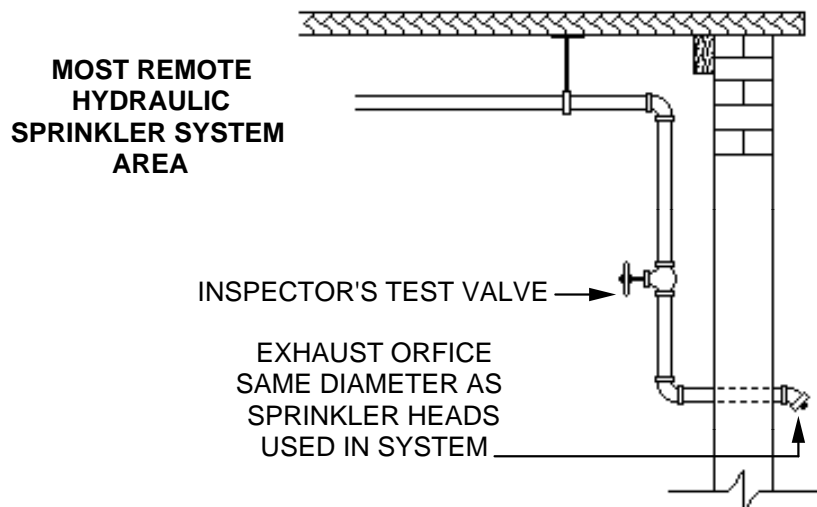
Prior to testing:

- Have the building operator or owner open and close all valves.
- Notify Dispatch of your test, give location and ask them to make note of the time of alarm received for supervised systems.
- Insure that the discharge from the inspectors test drain is to a safe area (i.e. doesn't cause erosion & property damage).

Testing Sequence:

1. Open the Inspector's test valve. Alarm should sound between 15 and 60 seconds. Observe the color of water discharging. This should clear up within 30 seconds.
2. After the test is complete, make sure all valves are back to operational positions.
3. Check that all control valves are open and sealed or locked.
4. Check the FDC. Make sure the female coupling is free to rotate, threads are in good shape, and caps are in place.
5. Check stockpiling. Top of piles should not be closer than 18 inches vertically to the sprinkler deflectors.
6. Check for any walls or partitions, which may have been moved. Walls should not be more than 7 1/2 feet from a sprinkler measured at a right angle with the wall.

INSPECTOR'S TEST VALVE



Dry Pipe System Testing

The main drain test should be conducted annually. Quarterly tests are recommended, except when the weather is extremely cold. Alarm tests should be conducted at least once a month, though weekly testing is suggested. During these tests visual observations for irregularities should also be conducted.

1. Observe and record the static pressure of the gauges, (i.e., both the water and air pressure gauge).
2. Slowly open the two-inch main drain valve to check the water flow into the sprinkler system. NOTE - the drain valve must be opened slowly to avoid tripping the dry-pipe valve.
3. Observe and record water and air flow pressures.
4. Slowly close the drain valve.

Test the alarm by opening the alarm by-pass valve.

OTHER TYPES OF FIRE PROTECTION SYSTEMS

Introduction

There are several other types of fire protection systems that are able to offer efficient protection against fire. Some systems are connected to a fixed supply of fire suppressing expellant like chemical systems. This type of system is referred to as a fixed extinguishing system. Sprinkler systems are also considered fixed extinguishing systems if the water supply is limited (i.e., water tanks).

Some systems are unable to react to fire by themselves (i.e., dry standpipes), but rather are hose hookups, which facilitate fire suppression operations without having to process long hose evolutions to the fire. Other systems will supply a number of small linen hoses, which can be used to contain the fire. Finally, firefighters may encounter systems that are a combination of any of the mentioned fire protection systems, including sprinkler systems.

Chemical Systems

Chemical fire protection systems are utilized mainly when there is concern for damage to vital or expensive equipment and/or documents. Typically, they are used when human occupancy is uncommon because the expellants may be either asphyxiants or toxic. There are several varieties of chemical fire protection systems including:

- Carbon dioxide
- Halogenated agents
- Foam
- Wet and dry chemicals

It is very important that all firefighters entering an area where chemicals have been used to extinguish a fire wear their SCBAs and full turnouts. Firefighters will not test any fixed extinguishing systems. Rather they are responsible to ensure the systems are in working order by checking the inspection tags for current dates and gauges for correct pressures.

Carbon Dioxide

The basic operation of this system includes a pre-discharge alarm to warn the occupants CO₂ will be discharged from the system followed by actual discharge. The system can be initiated either automatically or manually. The CO₂ is applied in one of three methods: the entire area is flooded, replacing the entire atmosphere with carbon dioxide, local application could occur in the affected area only, and/or extended discharge, where CO₂ discharge continues for a timed period after the fire is contained.

In most cases, this system will only be used when human occupancy is uncommon or infrequent (e.g., sub-stations). The reason for this is the asphyxiation properties of CO₂. The main concern for firefighters is the possibility of asphyxiation to individuals in the structure since the system should have activated by the time firefighters reach the scene. Therefore, a thorough search of the area should be made to determine if there is anybody in the structure. Once rescue procedures are complete and if the fire is still burning, firefighters may wish to use another extinguishing agent. The officer in charge may wish to seal the structure to help contain any remaining fire. This decision may be dependent upon the amount of damage that could occur from smoke.

Carbon dioxide systems must be installed and tested in accordance with NFPA Standard No. 12. Qualified technicians should conduct the tests.

Halogenated Agent

The operation of these systems is much the same as carbon dioxide systems. They may initiate automatically, manually, or by both means. The system can be designed to discharge locally or by total flooding of the area. The precautions associated with carbon dioxide systems will also apply to halogenated systems. Wear a SCBA, perform rescue operations, and use reserve-extinguishing agents only if the Halon expellant is not sufficiently containing the fire. The structure should be ventilated before entering.

Foam

There are several different types of foam extinguishing agents. These include alcohol, regular and fluoroprotein, detergent, and high expansion foams. The basic operation of all foam systems requires a mixture of uncontaminated air, water, foam, and mechanical agitation. The most prevalent use for foam is petroleum fires. The system may expel the foam in many different ways including nozzles, sprinkler heads, troughs, tubes, injection into a structure, or tanks.

Dry and Wet Chemicals

These systems are employed effectively in areas where flammable liquid fire could occur. They are particularly effective in containing grease fires. These systems can often be found above cooking stoves, fryers, and broilers at restaurants and food processing plants. Firefighters may also encounter chemical fire protection systems when dealing with heavy machinery and equipment fire (i.e., modern bulldozers, etc.). In this case, pneumatic tubing is employed to deliver the agent. Wet and dry chemicals can be delivered by total flooding or by localized application. Firefighters should always wear SCBAs and approach these systems cautiously. The fires that they are constructed to contain burn at very high temperatures and have the capability of releasing brief amounts of high thermal energy when coming in contact with the chemicals. Annual or semi-annual inspections of the system should be made, including checking the pressure gauge for the proper pressure and the tag date.

Class I - Wet or Dry Standpipe Systems

Wet or dry standpipes are required on all buildings four or more stories in height. Typically, they consist of a fire department connection at ground level on the same side as the main entrance, which is attached to risers within the structure. The riser(s) are usually located in the stairwells, each having a 2-1/2" outlet at every landing above the first floor. Large structures will have enough risers and outlets so all areas of the structure are accessible to fire hose. There are exceptions to the location of the fire department connections and outlets; therefore, pre-fire planning is essential if the standpipe system is to be used efficiently. For example, older structures may have dry standpipe risers, which run next to an exterior fire escape.

Class II - Wet Standpipe Systems

These systems are connected directly to a water source and the outlets feed pre-connected fire hose. The outlets are usually 1-1/2", and are connected to 100' of lightweight linen fire hose. Wet interior systems are designed for use by the occupants of the structure and therefore, will not expel water at the same pressure a firefighter may be accustomed to.

Class III - Combination Standpipe Systems

These are wet fire protection systems, which include a pump similar to fire department pumpers. Combination standpipe systems are required in any building exceeding 75' in height. The pump must be able to expel 500 gallons per minute (gpm) at 65 pounds per square inch (psi) at roof level.

These systems will have only one fire department connection from which apparatus pumps can override the structure pump. A check valve is integral to the fire department connection, and inhibits water flow out of the fire department connection. These systems will usually have risers in each stairwell. At least one 2-1/2" outlet from the riser is available at each landing above the first floor.

Combined Systems

Combined systems integrate both a wet standpipe system (with 1-1/2" pre-connected linen fire hose and/or 2-1/2" outlets for fire hose connections) and a wet pipe sprinkler system. This system is common in many modern buildings. In fact, newer high-rise structures (built after 1979) are required to have both combined and combination systems. The system must include: a reserve water supply of 7,500 gallons, 2-1/2" standpipe outlets and sprinkler supply lines on each floor, and a 500 gpm fire pump.

WATER SUPPLY SYSTEMS

Introduction

Water supply systems are essential to the life and welfare of the community. Not only do they supply the needs of individuals within the community, they are also designed to deliver large quantities of water when the conditions warrant. Water supply systems are built to fit the specific needs of the area or occupancy and in most cases will consider the needs of both individuals and fire protection.

Firefighters should have an understanding of water supply systems for several reasons. Comprehension of the type of system will aid the firefighter when he/she makes decisions about how to attack a fire (i.e., limitations of the distribution source, usability of system, etc.). A good working knowledge of water supplies will help promote a good relationship between the fire department and the public services when the two must work together. Finally, by understanding the systems capabilities and limitations (i.e., age, damage, clearances, and friction loss), firefighters can determine the effectiveness of the system when fighting a fire.

Components of Water Supply System

The local water system is supplied from Northern California, the Colorado River and local runoff. The water from Northern California and the Colorado River is stored in reservoirs. The reservoirs take the form of man-made lakes and tank reservoirs at the top of hills (impounded supplies). There is very little ground water to speak of in the San Diego area, except in the rural areas of the county where private wells may be encountered.

Distribution of the water from the supply source can take one of three forms: pumps, gravity, or a combination of both. In most cases, water is moved via pipe rather than open channels. Commonly referred to as water mains, these systems of pipes service both the intermediate supply sources and community distribution. In most cases cast iron and cement pipes are used for this purpose. However, steel reinforced concrete is used when extra protection from situations which could stress and break the water mains (i.e., highways, railroad tracks, heavy machinery, and earthquakes). Water mains in older residential districts are usually 4" and 6" in diameter. Current mains are either 6" and 8" in diameter when a good "grid" can be completed, or 8" and 12" when long distributions are laid which cannot be interconnected with other grids.

A distribution grid consists of a network of water mains used to supply water to residential communities and fire hydrants. A grid network will contain the following:

- Primary Feeders
- Secondary Feeders
- Distributors

- Water Main Valves
- Residential Hookups
- Fire Hydrants

Each component, except residential hookups, will be covered in detail. It is important to note most grids are interlaced with other grids.

Primary Feeders

Primary feeders are large pipes (4 to 12 inches), which distribute large quantities of water to both intermediate supply sources and local residential districts for supply to Secondary feeders. These are the arteries of the water distribution system.

Secondary Feeders

These are a network of pipes within a particular residential district. They are intermediate in size (2 to 6 inches) and loop off of the primary feeders. These are the arterioles of the water distribution system.

Distributors

These are the capillaries of the water distribution system. They are the smallest of the distribution pipes and supply individual fire hydrants and blocks of consumers.

Water Main Valves

These valves control the flow of water through the distribution system. They are located at frequent intervals (500 feet apart in high valve districts, 800 feet elsewhere) within the grid system so only small areas will be affected if an area must be shut off. Under no circumstances should a Firefighter operate these valves. They usually reroute water to another grid and could possibly overload and rupture feeders to residential hookups, and hydrants in areas that would not otherwise be affected by fire department operations. These valves can be indicating or non-indicating, most are of the non-indicating type. Their principal operation is to provide water control when necessary (i.e., when a main breaks, etc.).

Hydrants

There are basically two types of fire hydrants, the dry barrel and the wet barrel. Firefighters in your City need only be concerned with wet barrel hydrants but dry barrels will be briefly covered.

Dry Barrel Hydrants

Mainly used in colder climates when freezing can occur. The valve on the hydrant is

located at the water main rather than at the port (fire hose connection). Therefore, the hydrant remains free of water that could possibly freeze and render it useless.

Wet Barrel Hydrants

Usually filled with water under pressure at all times. These hydrants are controlled by valves located at the fire hose connection. The valves are constructed out of a non-corrodible material such as brass. The valve nut, which opens the valve when turned counterclockwise, is pentagonal in shape, measuring 1-1/2" from point to flat.

Usability of Hydrants

There are a number of factors, which may influence the usability of a hydrant. These include obstructions, direction of the outlets, condition of the hydrant, and the flow of water when the hydrant is fully opened. Hydrants should be spaced at no more than 300 feet apart in commercial districts and 600 feet in residential. The hydrant should be set perpendicular to the ground with the lowest discharge port no less than 18 inches above the grade. When the final grade has not been completed, the hydrant should be placed only after consideration has been made for the grade of the land. The 18-inch clearance provides sufficient clearance for fire department connection to the hydrant (i.e., suctions with long lugs). Clearance around hydrants must be 30" in all directions. (Please refer to U.F.C. Section 10.) Foliage must not obstruct the hydrant in any manner.

REFERENCES

Fire Officers Guide to Extinguishing Systems, NFPA, Charles W. Bahme, 1970.

Fire Protection Handbook, NFPA, 1981.

IFSTA 210 Private Fire Protection and Detection, Fire Protection Publications, Oklahoma State University, 1979.

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