4.1
4.2

Course/Unit Learning Outcomes	Learning Activity
5.3	

Originally, sprinkler systems were designed to suppress or control fires in order to protect property in commercial and industrial structures. Some may believe the primary purpose is life safety; however, the main focus was property conservation and protection. The primary design was not to extinguish fires but to keep the fire under control until manual intervention could take place. Many times, sprinkler systems completely extinguish the fire by removing the heat while they are only able to reduce the heat at other times. Heat from a combustible must reach the predetermined activation temperature of the fusible link or heat-sensing element to melt or break it. This then will allow water to flow out of the orifice of the sprinkler head. There are several types of sprinkler systems: wet pipe, dry pipe, pre-action, and deluge systems (Brakhage, Abrams, & Fortney, 2016). In addition, there are special water-based systems, such as water mist and foam fire suppression systems. As seen in Unit II, there are myths and realities associated with water-based fire sprinkler systems. The standards for water-based sprinkler systems are found in the National Fire Protection Association (NFPA) 13: *Standard for the Installation of Sprinkler Systems*.

Points to Ponder Scenario

The warehouse storage was a light hazard when originally opened and later changed to Group A commodities. Combustibles in the warehouse were ignited when hot work was being performed by arch welders repairing the main support damaged by a forklift. There was no one monitoring the hot work operation when cardboard under the work ignited. The workers performing the hot work utilized a makeshift platform on a forklift to reach the area needing repair. The forklift operator left to assist another employee in the main office. After realizing the fire below, the workers had to climb down to evacuate the structure. There was no fire-extinguishing equipment within 100 feet of the hot work. Many of the products in the warehouse were easily ignited and supported rapid fire spread below the reach of the sprinkler heads. The sprinkler system was a wet system with 8K-type heads, 2860 upright rough brass, and 155 F rating with a half-inch orifice. Within the first 10 minutes of the fire, seven heads were flowing in a 1,500 square feet area of high-pile rack storage. The distribution pipe is 2 inches in diameter, and the spacing per head is 15 feet between heads. Each head protected an area of 225 square feet, and each head is spaced uniformly. The last inspection for the entire system indicated the static pressure was 40, flowing 1,002 gallons per minute (gpm) with a residual pressure of 20 psi.

The fire alarm control units (FACUs) did not sense the presence of the products of combustion and smoke conditions. The sprinkler system protecting the storage of aerosol cans that contained combustible contents, large amounts of cooking oil, plastic bags of coffee products, and cleaning products was at a minimum. These sprinklers were operating above the fire that was involving rack storage. This meant the sprinklers only controlled the fire above, allowing the fire to spread horizontally from rack to rack. Fire spread was assumed to be contributed to surface flame spread from rack to rack due to the large amount of fuel that quickly grew and spread across the ceiling. After the fusible link (heat-sensing element) reached its predetermined activation temperature, water was released and hit the sprinkler head deflectors; however, the pressure was too low to effectively absorb the heat being produced by the combustible products. In addition, the fire growth was intense, and within seconds, multiple sprinkler heads activated.

Sprinkler heads

Was the change in products that were stored in the warehouse critical to fire protection? Did the change in products make the system inadequate for fire protection? Should the entire sprinkler system have been changed with the addition of square footage? Did the change in storage height have an outcome on the effectiveness of the system on suppression?

Components of an Automatic Fire Sprinkler System

Components of an automatic fire sprinkler system can vary from distribution pipe, fittings, sprinkler heads, pipe supports, and valves (Brakhage et al., 2016). The components need to be tested and have Underwriters Laboratories (UL) certifications stating they meet or exceed performance standards listed in NFPA 13.

Wet pipe: One of the most inexpensive types of sprinkler systems is the wet pipe. This type of system means what the name states in that water is always in the distribution pipes. This type of system is also one of the most reliable systems. A disadvantage to wet pipe systems is that in low temperatures, the water will freeze. Wet pipe systems should only be installed in areas that maintain 40 degrees F, and the sprinkler head operating temperatures are normally 135 degrees F and 170 degrees F (Brakhage et al., 2016).

Dry pipe: Dry pipe systems are similar to a wet pipe with distribution pipes and sprinkler heads. Dry pipe systems utilize compressed air or nitrogen under pressure. Once the sprinkler head activates, the compressed air or nitrogen is released, allowing a valve to open to discharge water. Dry pipe systems are installed in areas that are subject to freezing temperatures (Brakhage et al., 2016).

Pre-action: The distribution piping in a pre-action sprinkler system is dry and uses fire detectors to activate the system. These systems are used in areas that need to remain dry, and any release of water from leakage or a broken pipe would do significant damage to equipment and products.

Deluge systems: Like the pre-action system, the deluge sprinkler system responds to fires in a similar manner. These systems use fire detector activation or manual pull stations to activate the system in order for water to flow. The deluge sprinkler heads are opened. When the deluge system is operating, all the heads are flowing water, and the system requires a large volume of water and adequate pressure to be effective. This type of system is used when the fire growth is rapid or when other systems may not effectively extinguish the fire.

Water mist: Water mist systems are very similar to wet sprinkler systems, except for the fine spray mist of water droplets discharging from nozzles instead of sprinkler heads. The droplet size must be 1,000 microns or less. Droplets extinguish by displacing oxygen and cooling or blocking the radiant heat.

Foam Fire Suppression

Foam systems are specialty protection systems that are designed to protect flammable and combustible liquid hazards when water will not extinguish the fire. These systems form a blanket of foam over the flammable or combustible liquids, eliminating the oxygen and containing any flammable vapors. Foam also has a cooling effect and separates the fire from the fuel (Brakhage et al., 2016).

Sprinkler Head Discharge

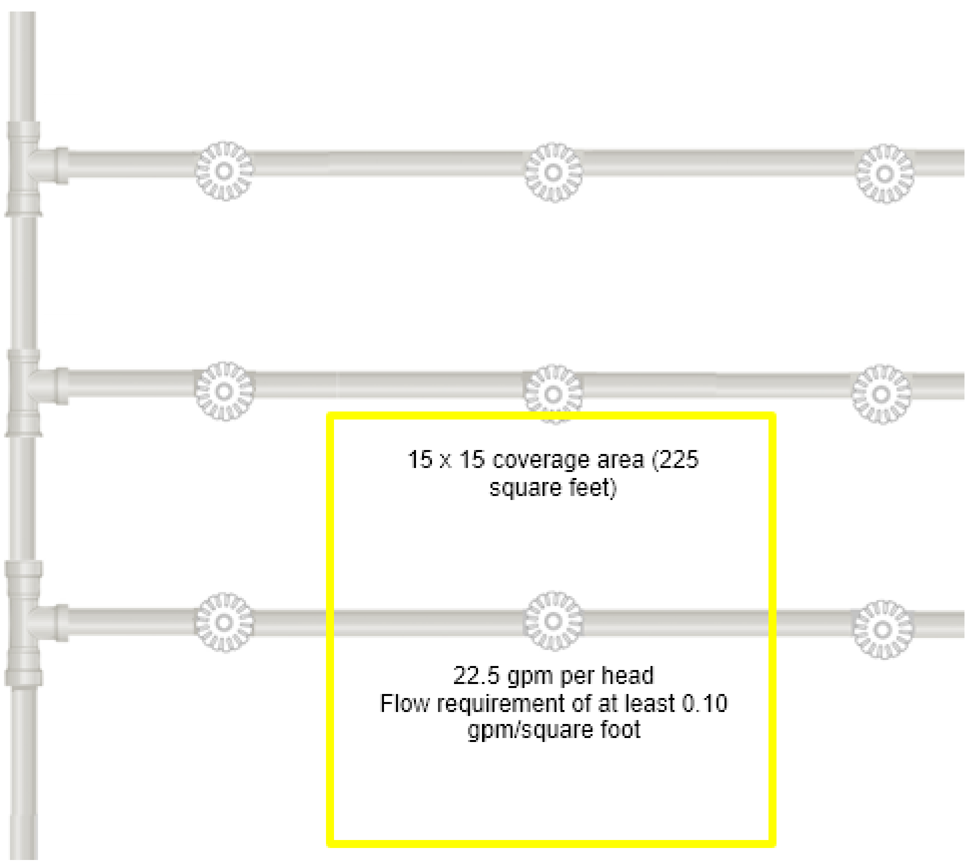
In the scenario, the sprinkler heads are spaced uniformly at 15 square feet. When sprinkler heads are equally spaced, then the flow rate for a single head can be calculated using the density times the remote area covered. The K factors range between 5.5 and 5.75 for a nominal half-inch orifice. NFPA 13 standards advocate that sprinkler heads flow at least 0.10 gpm/square foot in the remote area of coverage. NFPA 13 states that the remote area is considered the piping farthest from the water supply. A rough rule for determining the amount of water needed is to multiply 0.10 gpm/square foot by 1,500 square feet of the remote area in the scenario. This method is considered to be less accurate and only an estimate.

The NFPA 13 flow requirement of at least 0.10 gpm/square foot over the entire remote area of 15 feet by 15 feet in the scenario is the amount of water needed per sprinkler head. To determine the gpm per head, multiply 15 feet by 15 feet for 225 square feet. Then, multiply 225 square feet by 0.10 gpm/square foot for a total of 22.5 gpm per head.

To determine the total number of sprinkler heads needed in the area of 1,500 square feet, you divide 225 square feet (15 x 15) into 1,500 square feet, which equals 6.66 heads. This is rounded up to 7 heads. Then, the total amount of water needed is 22.5 gpm per head, times the 7 heads for a total of 157.5 gpm.

To determine the pressure needed for each sprinkler head to provide 22.5 gpm per head flow, the equation of Q = flow, K = coefficient of sprinkler orifice, and P = pressure is used.

$$P = \frac{Q^2}{K^2} = \frac{22.5^2}{5.6^2} = 16.14\ psi$$



Sprinkler system coverage for 15 x 15 area

Hot Work (Welding, Cutting, Brazing)

Hot work is anything capable of generating a spark or heat from welding, cutting, grinding, burning, melting, or brazing that can lead to a fire. Several authors suggest that hot work has contributed to several major fires recently and involve inherent fire risks and hazards (Ahrens, 2016; Oyewole, Parasram, Shroff, & Banks, 2017). There are several NFPA standards and codes that deal with hot work, from NFPA 51B: *Fire Prevention During Welding, Cutting, and Other Hot Work* through NFPA 326: *Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*. For more information, visit the NFPA.org website to view the codes and standards. In addition, OSHA outlines adequate controls in place for hot work in CFR 1910.252-255.

Should the arch welders in the scenario have followed any standard or code? Was keeping the warehouse in operation more important than stopping and taking time to follow the standards and codes? Should someone have ordered a stop work? If so, who had the authority in the scenario? NFPA standards state that fire watch should be provided by anyone designated by a supervisor to monitor the hot work. These individuals' only function is to watch for any fire development or hazardous condition that may occur (Colonna, 2016). The standard continues to state that the individuals must be trained to recognize fire hazards in the work area and understand fire development and behavior and how heat is transmitted through conduction, radiation, or convection. They should also have authority to stop any operation, no matter who may be pushing to have the work completed (Colonna, 2016). The individuals on fire watch must have been trained on how to use fire extinguishers and have them close and ready to operate. Lastly, they must be familiar with any procedures and be able to activate the alarm if a fire would occur. The fire watch must know the location of the nearest emergency pull station and telephone to report an emergency. The individuals should also be knowledgeable about the process of binding metal using high voltage or compressed gases, which can be hazardous.

Conclusion

Sprinkler systems have been used to control and extinguish fires. Originally designed to protect property, today several types of sprinkler systems are used to provide life safety, property conservation, and protection. NFPA 13 standards provide requirements of installation, maintenance, and testing. In addition, hot work has specific requirements, standards, and codes that must be adhered to for life safety and the protection of property.

References

Ahrens, M. (2016). *Structure fires started by hot work* (NFPA No. PKG 27). https://www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics/Appliances-and-equipment/osHotWork.ashx

Brakhage, C., Abrams, A., & Fortney, J. (Eds.). (2016). *Fire protection, detection, and suppression systems* (5th ed.). Fire Protection Publications.

Colonna, G. (2017, May/June). 5 hot work misconceptions. *NFPA Journal*. https://www.nfpa.org/News-and-Research/Publications/NFPA-Journal/2017/May-June-2017/Features/Hot-Work

Oyewole, S. A., Parasram, V., Shroff, R., & Banks, J. (2017, May/June). Hot work, safe work: Key lessons from the U.S. Chemical Safety and Hazard Investigation Board investigations of hot work incidents. *NFPA Journal*. https://www.nfpa.org/News-and-Research/Publications/NFPA-Journal/2017/May-June-2017/Features/Hot-Work

Suggested Reading

In order to access the following resource, click the link below.

You are encouraged to read how hot work is an important part of repair, renovation, construction, and demolition activities, and when precautions are not followed, fires, serious injury or death, and damage to property can occur.

Oyewole, S. A., Parasram, V., Shroff, R., & Banks, J. (2017, May/June). Hot work, safe work: Key lessons from the U.S. Chemical Safety and Hazard Investigation Board investigations of hot work incidents. *NFPA Journal*. https://www.nfpa.org/News-and-Research/Publications/NFPA-Journal/2017/May-June-2017/Features/Hot-Work