Course Learning Outcomes for Unit IV

Upon completion of this unit, students should be able to:

1. Recommend appropriate fire protection systems for protecting life and property.
   1.1 Discuss the characteristics of fire brigades in the industrial or commercial setting.

6. Evaluate design specifications for fire alarm systems.
   6.1 Define the terms *pressure, low,* and *duration* as they relate to the movement of water in private or public water systems.
   6.2 Identify and describe the components of a water supply and distribution network.
   6.3 Discuss the difference between some public water systems and private water systems.

Course/Unit Learning Outcomes	Learning Activity
1.1	Unit IV Lesson Chapter 3 Unit IV Course Project
6.1	Unit IV Lesson Chapter 3 Unit IV Course Project
6.2	Unit IV Lesson Chapter 3 Unit IV Course Project
6.3	Unit IV Lesson Chapter 3 Unit IV Course Project

Reading Assignment

Chapter 3: Water Supply Systems

Unit Lesson

Water is the most common and most plentiful firefighting extinguishing agent. Understanding the properties of water is critical in the design of fire protection systems. Designers must know the quantity of water for a given structure, the pressure required for the fire suppression system, and the friction loss of the system. They must also know the variables that affect water distribution in both private and public systems. Understanding water in relationship to temperature is also critical in that it changes the properties and weight of water.

Does a fire suppression system in Florida need more water to absorb the heat of a fire than a fire suppression system in Michigan? The law of specific heat measures the amount of energy needed to raise its temperature. Brakhage, Abrams, and Fortney (2016) explain that it takes 1 joule of heat to 1 pound of water to warm it by 1 degree Fahrenheit at sea level. HotSpot Energy (n.d.) suggests the average temperature of groundwater in Florida is 72 degrees, and the average in Michigan is 47 degrees. Will the groundwater in Michigan absorb more heat faster because it is colder and converts to extinguishing properties sooner? Brakhage et al. (2016) suggest that the extinguishing effect of water is affected by the law of specific heat, law of latent heat of vaporization, surface area of the water, and specific gravity.

We know that the temperature of water will not increase beyond the boiling point of 212 degrees before it turns to steam. According to Brakhage et al. (2016), water at an average temperature of 60 degrees needs

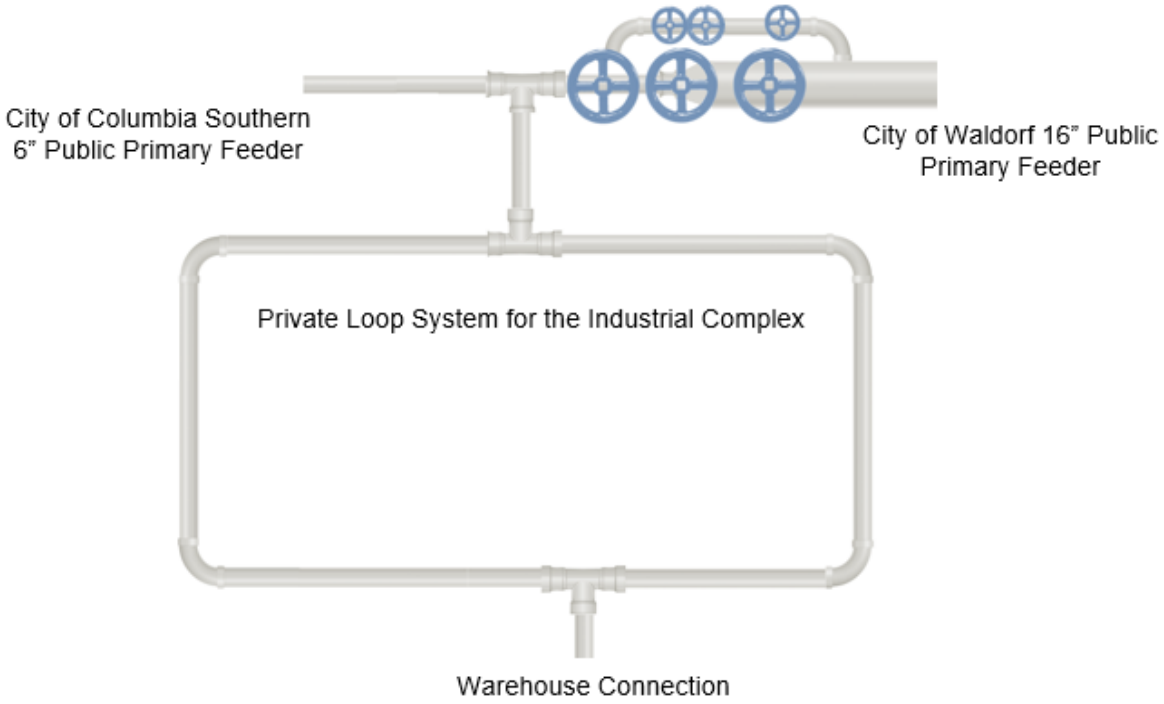
152 British thermal units (BTUs) to raise the temperature of water to the boiling point of 212 degrees. If we use the average groundwater temperature of 72 degrees, you will need 140 BTUs to raise the temperature of water to the boiling point; if we use the average groundwater temperature of 47 degrees, you need 165 BTUs to raise water to the point of boiling. The physics of water is needed to understand how much water would be required to convert water into steam for extinguishing fires. One gallon of water at 60 degrees and 152 BTUs of heat will convert into steam absorbing 9,358 BTUs of heat. In firefighting, water needs to be applied effectively to achieve the maximum conversion into steam to absorb the heat from a fire. If you see firefighters applying water inside a structure and water is running out the door, then it is not being applied effectively to the seat of the fire. The same is true with fire protection systems. To extinguish a fire, water must be applied to the seat of the fire in order to be converted into steam.

Water Systems

Have you ever noticed the fluctuation of the water pressure? Sometimes the pressure seems high while it may seem low at other times. Water demands of a community change continuously during peak usage depending on the time of day, week, month, or year. This may leave public water systems inadequate to support fire suppression efforts or even supply fire protection systems. Even though the availability of water seems plentiful in most communities, for firefighting, it can be challenging at times. Fire protection designers must understand these fluctuations and the properties of water in order to design a proper fire protection system. This includes flow rate requirements of the sprinkler system and firefighting efforts to mitigate a fire. The needed flow rate is the number of gallons of water required to extinguish a fire based on the building type, occupancy, and hazards. The amount of water required for sprinkler systems and firefighting from the public water system is based on pressure, flow, and duration of operation. Determining these factors is critical in the design.

Points to Ponder Scenario

During the fire, several workers reported that the sprinkler heads in front of the loading dock doors were barely operating. They also stated several sprinkler heads directly over the fire, which was started by the welders, activated. A couple of the workers wearing their normal uniforms (non-fire rated) attempted suppression activities during the initial fire stage using a hose rack, pre-connected, 1-inch fire hose that was a part of the existing structure before the renovation. However, the water stream would not reach the fire because there was no pressure. The workers also stated that a rusty colored water was coming out of the sprinkler heads and the fire hose line. The public water supply system for the community is ageing, and deterioration of many of the water mains has caused unreliable water supply during the maximum daily consumption. The water supply for the multiple sprinkler heads that were activated comes from a 6-inch private loop off of the secondary feeder from the City of Washington. Just past the loop is a cross-connection control device connected to the City of Greenville public water supply system, which is a primary feeder. The City of Greenville's water main is a 16-inch main reduced down to 6-inches at the cross-connection control device. The storage tank feeding the industrial area is 200,000 gallons maximum, and recovery time to fill the tank is 2 hours. The City of Washington is unable to boost the pressure due to the deterioration of the water system. After the fire and during the investigation, it was found that when the warehouse first opened, there was a fire brigade due to the distance to the closest fire station. The insurance company required staff to be trained to fight fire in order to receive a reduction in premiums. Two employees trained as a part of the original fire brigade that remained after the new owners reorganized the warehouse. However, the new owners did feel the need for a fire brigade but also felt it increased liability after conducting a risk analysis.



Was the private loop system effective? Did it provide enough water to the warehouse to supply the sprinkler system? In order to be effective, water supply systems should be fed from multiple distribution connections and directions using grids and loops. The least effective water supply system is one that is on a dead-end such as in the Points to Ponder Scenario. One of the signs that the water system was on a dead-end was the sediment that accumulated in the water lines from being static and reports of the rusty colored water. After the sprinkler system activated, the discharge of large amounts of water caused the sediment to break free. In addition, dead-end mains typically have low pressure due to water being supplied from only one direction.

Brakhage et al. (2016) suggest that loop systems are also referred to as circle systems. Typically, the loop system supplies water from two different directions. However, as seen in the scenario, the water is supplied to the private loop from only one direction making it like a dead-end main. Dead-end mains only allow water to travel in one direction reducing the availability (Brakhage et al., 2016).

Cross-connection control device.

Fire Brigades

Should fire brigades be utilized in fire suppression efforts? Should fire brigades be involved in emergencies when they occur? National Fire Protection Association (2018) or NFPA 1081: *Standard for Facility Fire Brigade Member Professional Qualifications* discusses the magnitude of fire brigades when dealing with fire emergencies. Fire brigade members should have the knowledge and skills to mitigate fire in an organized industrial setting providing specific services. Fire brigade members may preform suppression, rescue, or both, in fire related incidents (NFPA, 2018). The intent is that fire brigade members will be able to control the fire in the initial fire stage before it reaches the fully developed stages. Fire brigade members utilize fire hoses from Class I, Class II, and Class III standpipe fire suppression systems; although, Class II systems are less demanding with better control with lower pressure and volume requirements for individuals to handle (Brakhage et al., 2016). The standard stresses the importance of individuals in the fire brigade to have proper training, equipment, and protective clothing.

Conclusion

Water is critical in the extinguishment of fire, and understanding the properties of water makes firefighting more effective when applied properly at the seat of the fire in order to convert to steam. Water distribution systems, both private and public, are important in the ability to deliver water to fire protection systems. As seen in the warehouse fire in the scenario, the effects of firefighting, from a fire brigade or a fire protection system, can be disastrous when water is not readily available. Not having adequate water for fire suppression can be life threatening.

References

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

HotSpot Energy. (n.d.). Ground water temperature map - Entering water temperatures [Climatic map]. Retrieved from http://www.hotspotenergy.com/heat-recovery-performance/groundwater-temperature-map.php

National Fire Protection Association. (2018). *Standard for facility fire brigade member professional qualifications* (NFPA Standard No. 1081). Retrieved from https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=1081

Suggested Reading

In order to access the following resources, click the links below.

You are encouraged to read the trends and technologies related to municipal water supply systems with a focus on interoperability, backup and redundant water supply systems, and critical infrastructure protection.

Hickey, H. E. (2008). *Water supply systems and evaluation methods: Volume I: Water supply system concepts.* Retrieved from https://www.usfa.fema.gov/downloads/pdf/publications/water_supply_systems_volume_i.pdf

Hickey, H. E. (2008). *Water supply systems and evaluation methods: Volume II: Water supply evaluation methods*. Retrieved https://www.usfa.fema.gov/downloads/pdf/publications/water_supply_systems_volume_ii.pdf

In order to view National Fire Protection Association (NFPA) standards, each student must register for a free account with the NFPA. Please review the video tutorial on gaining access to the NFPA website and how to access the NFPA codes there.

Locating and Using NFPA Standards Tutorial: http://libguides.columbiasouthern.edu/nfpastandards

Click here to access the transcript for the tutorial above.

Once you access the codes and standards, review NFPA 1081: *Standard for Facility Fire Brigade Member Professional Qualifications.*

National Fire Protection Association. (2018). *Standard for facility fire brigade member professional qualifications* (NFPA Standard No. 1081). Retrieved from https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=1081