Course Learning Outcomes for Unit VIII

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

1. Recommend appropriate fire protection systems for protecting life and property.

2. Apply sound ethical principles as they relate to fire protection.

3. Explain how the properties of fire influence design and installation criteria.

4. Recommend appropriate procedures for applying different types of foam systems.

5. Examine emerging technologies related to fire protection.
   5.1 Describe the components and accessories common to smoke management and smoke control systems.

6. Evaluate design specifications for fire alarm systems.

Course/Unit Learning Outcomes	Learning Activity
1	Unit VIII Course Project
2	Unit VIII Course Project
3	Unit VIII Course Project
4	Unit VIII Course Project
5.1	Unit VIII Lesson Chapter 7 Chapter 8 Unit VIII Course Project
6	Unit VIII Course Project

Reading Assignment

Chapter 7: Non-Water-Based Fire Suppression Systems

Chapter 8: Smoke Management Systems

Unit Lesson

Non-Water-Based Fire Suppression Systems

For some ordinary structures, sprinkler systems may not be enough to extinguish special hazard fires using water only, as water damage may be detrimental to the contents of the occupancy. In these incidences, specialized suppression systems are needed to extinguish the fire without unintentionally damaging the contents. According to Gagnon (2008), non-water-based fire suppression systems protect a variety of hazards with unique challenges that water-based suppression systems are not efficient at protecting. Brakhage, Abrams, and Fortney (2016) categorize special hazards as large quantities of flammable liquids, valuable or irreplaceable commodities, metals reactive to water, high-tech research, and switching equipment. Specialized or non-water-based fire suppression systems may include wet chemical, dry chemical, clean agents, and carbon dioxide.

Wet chemical fire suppression systems use foam systems where two-dimensional fires occur, such as cooking oils. At room temperature, cooking oils do not produce any flammable vapors to be concerned with autoignition. However, when heated, cooking oils will ignite spontaneously. The appropriate type of foam system to protect the hazard is a wet chemical that reacts with the cooking oil, producing saponification. In addition, the wet chemical will cool and smother the flame (Gagnon, 2008). Wet chemical extinguishing agents are applied through systems that may be fixed, semi-fixed, portable, or mobile. These systems extinguish, prevent, and control fires in facilities that store flammable or combustible liquids.

Dry chemical suppression systems use a chemical residue, such as sodium bicarbonate and monoammonium phosphate, to extinguish fires. Brakhage et al. (2016) suggest that after a dry chemical suppression system is discharged, the residue left behind creates a cleanup problem and can corrode equipment and hinder the operation.

Clean agent suppression systems use inert gases made from a mixture of helium, neon, argon, nitrogen, and small amounts of carbon dioxide. This mixture of gases was developed to replace Halon 1301, due to the environmental concerns and toxicity of halon. Clean agent systems protect computer, telecommunications, data storage areas, document rooms, art galleries, museums, and other high-valued areas (Brakhage et al., 2016). Clean agents interrupt the uninhibited chain reaction of the tetrahedron.

Carbon dioxide suppression systems use odorless, colorless, noncombustible, nonconductive gas to displace oxygen to extinguish the fire. Carbon dioxide is heavier than air and is dangerous to anyone entering the room or area when it is discharged.

Points to Ponder Scenario

The warehouse fire involved high-pile rack storage of 275-gallon intermediate bulk container (IBC) totes containing cooking oil that spread pools of fire igniting other IBC totes and combustible products. As the workers attempted to extinguish the fire with water, the water hit the cooking oil, causing small explosions that spread the burning oil even further. As the fire increased, the high temperature caused more totes to became involved, producing thick black smoke, toxic substances, and asphyxiates, which flowed horizontally throughout the warehouse under the roof. The flow of the smoke started gradually and began to turn more turbulent near the heated gases. The smoke at the fire near the cooler metal walls of the warehouse began to drop down, creating layers closer to the floor. In the heated areas, the high velocity driven smoke began to stratify into layers because of its buoyancy remaining higher than the cooler smoke. Then, the sprinkler system activated cooling some of the heated smoke near the fire, reducing its buoyancy. In other parts of the warehouse, the smoke continued to build under the roof area. Once the entire area under the roof was covered, the smoke started banking down and working its way into the ductwork and openings in the office area, exposing workers. The smoke from the cooking oil and other products contained sufficient toxic asphyxiates that began to overtake the workers within just a few minutes. During the investigation, it was found the warehouse was not equipped with smoke management or smoke control systems.

Did the warehouse in the scenario require a specialized suppression system? Did the warehouse require some type of smoke control or smoke management system? Warehouses unlike other structures are not compartmentalized where shutting doors may control smoke and reduce the rapid growth of the fire.

Smoke Management Systems

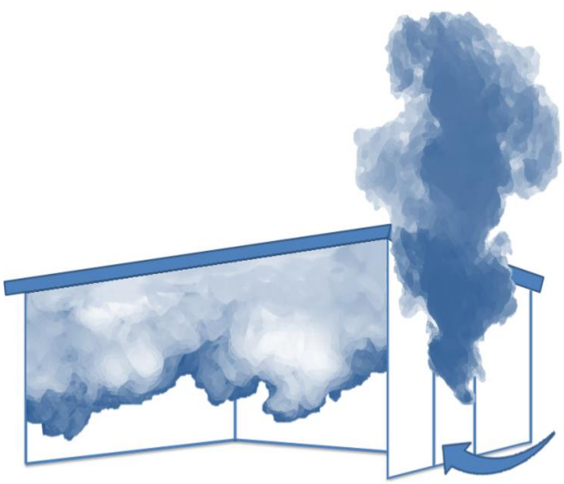
Smoke management and smoke control systems limit the spread of smoke as though a door was shut in a compartmentalized structure. Smoke management and smoke control systems use mechanical fans to produce airflow and pressurize areas removing smoke or limiting the movement to control smoke inside high-rise buildings, covered malls, and warehouses with high-piled rack storage. These methods of smoke control are containment, extricate, or opposed airflow. Controlling smoke and its movement is critical for providing a tenable environment for these same occupancies allowing safe evacuation and firefighters to be able to mitigate the fire quickly. The design of smoke management and smoke control systems takes into consideration the buoyancy and stack effect that influence the spread of smoke and the heat gases.

Smoke management systems utilize mechanical fans, dampers, and other methods to remove smoke from structures. Smoke management systems' intended uses are roof hatch ventilation in high atrium spaces, smoke exhaust fans in parking garages, pressurization fans in stairwells, pressurization fans in elevator shafts, and smoke exhaust fans in large warehouses (Ventola, 2014). The National Fire Protection Association (NFPA) 92B: *Standard for Smoke Management Systems in Malls, Atria, and Large Areas* describes methodologies for estimating the location of smoke within large-volume space or in an adjacent space (Gagnon, 2008). Gagnon continues to promote that the standard assists fire protection design professionals in determining if smoke will stratify or not by using the following formula.

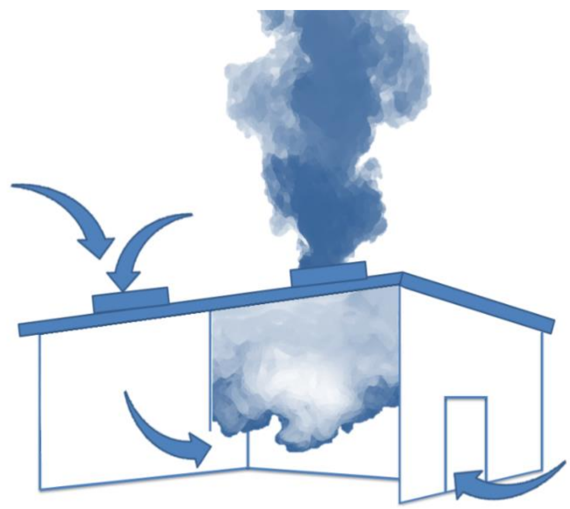
$$Z_m = (14.7) \times (Q_c^{1/4}) \times (\Delta T/\Delta z)^{3/8}$$

Gagnon (2008) suggests the formula determines the heat release data for different commodities in the equation of (Q_c), and the temperature is measured by ($\Delta T/\Delta z$).

Smoke control systems operate mechanical fans and dampers to create and maintain a pressure difference and smoke barrier. Smoke control systems are activated by electronic monitoring, and they control devices to inhibit smoke from entering spaces that are a means of egress or areas of refuge (Ventola, 2014). Brakhage et al. (2016) suggest that smoke control strategies utilize passive systems, pressurization systems, exhaust method, opposed airflow method, dilution, and zone smoke control. NFPA 92A: *Recommended Practice for Smoke-Control Systems* describes recommendations for smoke management using smoke barriers, airflows, and pressure differences to confine smoke movement to the area of origin (Heskestad, 1997).



Large volume warehouse with no smoke control system allows smoke to spread horizontally beneath the roof until it reaches an opening.



Smoke removal for a large volume warehouse uses ventilator fans at the roof line to extract the smoke and ventilator fans to replenish the atmosphere with fresh air being channeled by curtains containing the smoke.

Whether pressurization with mechanical ventilators or limiting smoke, control systems utilize two basic principles through passive and active systems to accomplish the extraction of the heat gases and smoke. Passive design utilizes smoke curtains and smoke ventilators found typically in warehouses with high-piled rack storage. Smoke ventilators open allowing the smoke and heat to escape through high-level ventilators in the roof and smoke curtains create a wall containing or channeling the smoke in one area allowing the smoke to be extracted. Active design utilizes mechanical means to extract or force the smoke out when the fire protection initiation device receives a signal activating the ventilators to extract the smoke and replace the air being extracted with fresh air.

Conclusion

Non-water-based fire suppression systems are required when water-based systems are not effective, react with materials, or damage equipment. Non-water-based fire suppression systems protect a variety of special hazards with unique challenges. In most cases, these water-based suppression systems are not efficient at protecting these special hazards that may be irreplaceable or products that react with water alone.

Smoke management and smoke control systems limit the spread of smoke when the consequences can be devastating. These systems create a tenable environment allowing occupants to exit the building more quickly in a clear path of travel where the smoke is kept at a high level. Smoke management and control systems ensure fires can be located and extinguished sooner, preventing more damage to the contents and structure.

References

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

Gagnon, R. M. (2008). *Design of special hazard and fire alarm systems* (2nd ed.). Albany, NY: Delmar Learning.

Heskestad, G. (1997). Venting practices. In A. Cote & J. Linville (Eds.), *Fire protection handbook* (18th ed.; Section 18, Chapter 4). Quincy, MA: National Fire Protection Association.

Ventola, M. (2014, November 10). Smoke control vs smoke management: An overview [Blog post]. Retrieved from https://blog.1sae.com/2014/11/10/smoke-control-vs-smoke-management-an-overview/

Suggested Reading

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

This video demonstrates a full-scale smoke control system conducted in a newly constructed 250,000 square foot furniture warehouse. The system uses vents in the middle of the roof to control fire spread.

Overholt, K. (2008, February 20). *Furniture warehouse smoke control and fire demo* [Video file]. Retrieved from https://www.youtube.com/watch?v=DE6uG-cPwts

Note that the video above does not contain dialogue.

Learning Activities (Nongraded)

Nongraded Learning Activities are provided to aid students in their course of study. You do not have to submit them. If you have questions, contact your instructor for further guidance and information.

These are manufacturers' websites that show the types of smoke management and smoke control systems that could be used to find recommendations for the rebuild of the distribution warehouse assignment. Visit a few of the websites to become familiar with what they offer.

http://www.airprodsales.com
http://www.ruskin.com
http://www.greenheck.com
http://www.prefco-hvac.com
http://www.ncamfg.com
http://www.unitedenertech.com
http://www.airbalance.com
http://www.arrowunited.com
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