Reading Assignment

Chapter 6:
Fire Dynamics

Unit Lesson

Think back to your high school days when you had to take chemistry, and if you were lucky, physics. You probably did not realize how important this information would be unless you were thinking of going into one of these fields after high school. Words like atoms, neutrons, protons, electrons, matter, and other scientific words and phrases sounded much like a foreign language to you at that time, and may still do if you have been away from high school for any length of time.

Fast forward to your adult life, here and now. You are thinking of becoming a firefighter, or are one already, and many of you are still wondering what this has to do with putting *wet stuff on red stuff* as the saying goes. Well, you are about to find out through the study of fire dynamics. This chapter in no way is intended to teach you everything about the science of fire. That would take an entire course or two, in and of itself. You will be exposed to some of the basics of fire and how it is formed. It is said by many great philosophers and scholars that fire is the most important discovery that mankind has made. Since that time, we have been studying the process in order to know how to harness it or extinguish it should it get out of hand.

Start at the Beginning

If you are to fully understand fire, you have to understand its makeup. Like everything in our universe, the atom is the building block to matter, just like bricks are the building blocks to a house. Like a house that is made up of many smaller parts, atoms are made up of smaller elements called protons, electrons, and neutrons. Their relationship to each other and other atoms creates different forms of matter that can exist in three different states known as solid, liquid, and gas. Each of these forms has its own specific characteristics that make it unique, and each exists around us at all times. Understanding the characteristics of each, how they react and depend on one another, and how this relates to fire in nature allows you to have a better understanding of the different forms of extinguishment you will use throughout your careers.

Energy

Loyd and Richardson (2014) define *energy* "as the capacity or ability to do work. Energy itself cannot be observed. We can only perceive and measure the work that it performs" (p. 101). Energy comes in several forms: heat, chemical, electrical, and mechanical. Each will be studied in depth throughout this course.

Heat energy is the process of transferring heat from the hottest to the coldest substance until they equal out (Loyd & Richardson, 2014). A good example of this is the burning of a match. You hold the match at one end (cold end) and strike it until a flame is produced (hot end). The flame consumes the material in between until the entire match is burning. You can watch the match burn from the hottest end to the coldest, and it will

eventually burn your finger if you hold it long enough. We can measure heat from this process as evidenced by thermometers and other scientific measuring devices in either degrees Fahrenheit, Rankine, Kelvin, or Celsius. Terms such as specific heat, latent heat, British thermal units (BTUs), and others will be used to describe heat energy and how it reacts and is measured in nature. As a firefighter, this type of energy is important because it dictates the type of PPE you wear as discussed in Unit III.

Heat energy is transferred in one of three methods, according to NFPA: conduction, convection, or radiation. In *conduction,* heat moves through matter, while heat transfer by *convection* is usually through gases and liquids. *Radiation* heat transfer differs from both conduction and convection transfers in that it does not need any form of matter for which to transfer its energy; it is done through infrared rays that are invisible to the human eye (Loyd & Richardson, 2014).

Chemical energy, according to Loyd and Richardson (2014), is the process that produces combustion through exothermic oxidation. This form of energy is the most common source of fires that we encounter in the fire service.

Heat of combustion, fire load and fire flow computations, and rate of heat release are terms and concepts that allow firefighters and more specifically, fire protection engineers, the ability to measure and calculate how fire will react and how it can be controlled. Heat can be generated spontaneously, through decomposition, through dissolving a substance in liquid, or when a substance comes in contact with a liquid or air (Loyd & Richardson, 2014).

Electrical energy comes in six different forms that are important for all firefighters to understand: resistance, arcing, sparking, static, lightning, and induction (Loyd & Richardson, 2014). Most of you are familiar with some or all of these forms as many are around you in your everyday lives. What you need to know and will learn is that each of these six are forms that, while they are harmless if properly managed, can cause catastrophic results when they are released and interact with ignitable matter.

Mechanical energy is heat energy created through friction or compression. Many of these types of fires are found in machinery or industrial fires.

Burning Process

Each of these forms of energy can and do create sufficient heat to start the burning process. Burning takes place in four distinct stages: ignition, growth, full development, and decay. To support burning, there are four elements that must be present at all times and in the correct proportions: heat, oxygen, fuel, and a chemical chain reaction. This is commonly referred to as the *fire tetrahedron*. Remove one of these legs, and the burning process ceases to exist, and the fire goes out. Understanding each of these elements and how to respond and eliminate them from the burning equation, is vital for the safety of each and every firefighter. Using the wrong extinguishing agent or trying to stop the burning process incorrectly, can result in catastrophic destruction, injury, or death. A prime example of this is in how you extinguish a grease or liquid fire. Putting water on this type of fire to try to cool it and remove the heat from the tetrahedron only makes it grow. However, removing the oxygen by smothering the fire will extinguish this type of fire as one leg of the fire tetrahedron has successfully been removed.

Fire Classifications

Now that we have discussed how the different types of energy that create fire are developed, measured, and attacked, it is time to classify each type of fire based on its type of fuel consumed. Loyd and Richardson (2014) list the five different classifications of fire as follows:

- Class A: Ordinary combustibles, which are made up of wood, paper, and organic solids, are primarily extinguished with water through cooling.
- Class B: Flammable liquids, which are self-explanatory, are attacked by smothering and cutting off the supply of oxygen.
- Class C: Energized electrical fires are started through electricity in one form or another. In these fires, it is important to remove the electrical current, then the fire can be extinguished the same as Class A and B fires.

- Class D: Flammable metals fires are maybe the toughest to combat since the chemical chain reaction must be interrupted in order to extinguish these types of fires.
- Class K: High-temperature cooking oil fires, once grouped as Class B fires, require special extinguishing agents to suppress these fires that are usually found in cooking establishments.

Conclusion

As far as basic firefighting lessons go, this is where the rubber meets the road. Without knowing where fire comes from, what it is made of, the different types of fire classifications, the burning process, and the different ways of combating fires, you will be putting yourself at great risk when faced with any emergencies involving fire. Your safety, and those of your crew and the public, rely on you making the correct call on how to attack these different fires.

Some of the information you will be presented will no doubt seem Greek to you at the beginning. However, once you learn the basics and have an understanding of the processes, you will be well equipped to do battle with any type of fire that you encounter.

Reference

Loyd, J. B., & Richardson, J. D. (2014). *Fundamentals of fire and emergency services* (2nd ed.). Upper Saddle River, NJ: Pearson.