Burn Notice

By: Vince McLeod - Published: January 6 2010

Now that most of us are experiencing the heart of winter, it is an especially good time to review our use and storage of flammable materials in the lab. Why now? Read further to find the answer; hopefully you will pick up some useful information in the process.

Flammable substances are those that can easily catch fire and burn in air. They may be solid, liquid or gaseous, but this article will focus on liquids for two reasons. First, according to *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals*, the most common fire hazard in the typical research lab is a flammable liquid or the vapor produced by one.[1] Second, for a majority of laboratories, flammable liquids are the most commonly stored materials and make up the largest volume of hazardous materials.

A quick review of basic fire safety is in order. We are all familiar with the "fire triangle"—the three conditions that must exist simultaneously for a fire to occur: an oxidizing atmosphere (usually air); a source of ignition; and a concentration of flammable gas or vapor within its flammability limits. If any one of these is absent, a fire cannot occur. Since air is nearly always present, controlling flammable vapors and gases and eliminating potential ignition sources are the best ways to reduce fire hazards. As flammables are used in most laboratories, strict control of all ignition sources is the primary approach to preventing fires.

Important physical concepts of flammable and combustible substances

The National Fire Protection Association's (NFPA's) *NFPA 30: Flammable and Combustible Liquids Code* is an excellent resource and introduction to the hazards of these materials.[2] Without getting too bogged down in technical details, there are a few concepts that need to be mentioned and understood at the outset. The first is flash point temperature. Flash point temperature is the lowest temperature at which sufficient vapor is given off to form an ignitable mixture in air. The flammable range is between the upper flammable limit (UFL) and the lower flammable limit (LFL). Flammable limits are expressed in percent volume in air. Concentrations above the UFL are too rich to burn and concentrations below the LFL are too lean to burn. The most dangerous materials are those with the lowest flash point and widest flammable ranges.

The next important concept is the difference between flammable and combustible liquids. Flammable liquids are more dangerous. These are liquids that have flash points below 100°F (37.8°C). Combustible liquids have flash points between 100°F and 200°F (93°C). *NFPA 30* further

classifies flammables as Class I, and divides them into Class IA, Class IB and Class IC. Class IA and IB both have flash points below 73°F (22.8°C), with IA liquids having boiling points below 100°F and IB liquids having boiling points above 100°F. Materials with flash points between 73°F and 100°F are classified as IC. Combustible materials are classified as Class II, Class IIIA and Class IIIB, based on flash points as well. Class II materials have flash points between 100°F and 140°F (60 °C), Class IIIA between 140°F and 200°F and Class IIIB above 200°F. The maximum quantity of flammable and combustible materials that can be stored in the lab is set in NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals and determines the hazard classification of the laboratory[3], as we shall see shortly.

One more thing: *NFPA 30* rates the fire hazard of flammable and combustible materials on a scale of 0 to 4, based on flash point. This rating helps you to quickly assess the potential danger of a substance. A 0 is the least hazardous rating; it indicates the material will not burn. A rating of 1 is given to materials with flash points above 200°F; this rating indicates the material needs to be preheated to burn. A 2 rating is for materials with flash points between 100°F and 200°F and indicates that these materials will ignite with moderate heat. Materials with flash points below 100°F and above 73°F are rated a 3 and will burn at normal temperatures. Flammables with flash points below 73°F are rated a 4 and are extremely flammable and the most dangerous. The fire hazard rating and flash point data are readily available on the container label and material safety data sheets.

Quick, what is the fire hazard rating of a Class II combustible liquid? OK, good work, it is a 2.

Important guidelines for storage of flammable and combustible materials

Now that we understand some basic concepts regarding flammable and combustible liquids, it is time to discuss proper storage of these hazardous materials. *NFPA 45* is the first reference we turn to, as it provides universal guidelines for safe storage.3 Chapter 4 of *NFPA 45* classifies laboratories into four fire hazard categories, based on the amount of flammable and combustible material in the lab. These are Class A (high fire hazard), Class B (moderate), Class C (low) and Class D (minimal). Educational laboratories (high school or through 12th grade) are Class D and are limited to 50 percent of the Class C quantities. Instructional labs are basically college-level undergraduate labs and are limited to Class C or Class D amounts. All others, including graduate, research and development labs, can fall into any of the four classes.

The heart of *NFPA 45* is chapter 10 (specifically, table 10.1.1), which lists the maximum quantities of flammable and combustible liquids that can be stored in laboratories. The most lenient in terms of

total amount is the highest fire hazard, Class A; it allows up to 10 gallons (38L) of Class I flammable liquid per 100 square feet, or 20 gallons (76L) of Class I, II and III flammable and combustible liquids combined. These quantities can be doubled to 20 gallons of Class I liquid and 40 gallons (150L) of Class I, II and III liquids if safety cans or storage cabinets are used. The total quantities drop to 5 gallons (20L) and 10 gallons for Class B, 2 gallons (7.5L) and 4 gallons (15L) for Class C and one gallon for Class D, with the same doubling rules in effect.

Also addressed in chapter 10 are the maximum capacities for different container types. For example, for Class IA flammable liquids, the largest allowed container is one pint (500ml) for glass, one gallon (4L) for metal and approved plastic or polyethylene, and 2.6 gallons (10L) for safety cans. These maximum capacities are listed for each class of flammable (Class IA, Class IB and Class IC) and combustible (Class II and Class III) liquids. So it is important to maintain awareness of both total quantities and your largest (in terms of size) containers.

Safely storing flammable and combustible liquids in laboratories or stockrooms is risky business. However, by paying attention to the hazard class of the material, the largest container size and the total quantities, we can minimize that risk. In addition, here are some general guidelines for safe flammable and combustible storage:

A few final words on ignition sources

We mentioned at the beginning the best way to prevent laboratory fires is to control ignition sources. The open-flame Bunsen burner is an obvious one we can easily focus on. But do not overlook the not-soobvious ones, such as refrigerators, stirring motors, electric hot plates, heat guns and microwave ovens. Check all things electrical and anything else that generates heat. For those who want to know, the dry winter air is perfect for generating, you guessed it, static electricity. And when static electricity arcs to the ground, you have an excellent ignition source. This is just one more reason to spend a few minutes going through your lab with this information fresh in mind. We hope this helps avoid any major incidents with flammable and combustible storage. As always, “Safety First” is an excellent motto.

Comments or questions are always welcome. Contact thesafetyguys@labx.com.

1. Committee on Prudent Practices for Handling, Storage, and Disposal of Chemicals in Laboratories, National Research Council. *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals*. Washington, D.C.: National Academy Press, 1995.

2. National Fire Protection Association. *NFPA 30: Flammable and Combustible Liquids Code*. 2008 ed. Quincy, MA: National Fire Protection Association, 2007.

3. National Fire Protection Association. *NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals*. 2004 ed. Quincy, MA: National Fire Protection Association, 2004.

Additional Resources

National Fire Protection Association. *NFPA 704: Standard System for the Identification of the Hazards of Materials for Emergency Response*. 2007 ed. Quincy, MA: National Fire Protection Association, 2006.

National Institute of Occupational Safety and Health. *NIOSH Pocket Guide to Chemical Hazards*. Washington, D.C.: U.S. Government Printing Office, 2005.

Clansky, Kenneth B., ed. *Chemical Guide to the OSHA Hazard Communication Standard* Burlingame, CA: Roytech Publications, 1989.

University of Florida. *Laboratory Safety Manual*. Gainesville: University of Florida Division of Environmental Health and Safety, 2003.