

## LABORATORY SAFETY – GUIDELINES FOR STORAGE OF FLAMMABLES

Flammables in buildings pose a special problem for occupants and users alike. Flammable storage at Kansas State University is regulated by the International Fire Code (IFC). The regulations can be found in Chapter 27 (2006 IFC). Additional guidelines exist in the National Fire Protection Association (NFPA), Fire Protection for Laboratories Using Chemicals (NFPA 45) and Occupational Safety and Health Administration (OSHA) Flammable Liquids (29CFR1910.106). Contrary to what most people think, Kansas State University is considered a business occupancy (Class B) in general. The addition of flammables and combustibles to the laboratories can change that occupancy classification. The guidelines, “Fire Protection for Laboratories Using Chemicals” (NFPA 45) states that this is all dependent on:

- construction of the laboratory;
- number of fire control zones in the building;
- floor level where the laboratory is located;
- whether the building has a fire protection system (fire sprinkler); and
- storage of flammable liquids in flammable liquid storage cabinets or safety cans.

The IFC is very clear about laboratory construction, the floor level where the laboratory is located and the presence of fire protection systems in the building. The location of the laboratory dictates how much flammable and combustible material can be used or stored on location. Being located on the first floor of a building allows 100% of the allowable quantity of flammable chemicals in the laboratory. As the location of the laboratory changes to the upper floors or basement floors, the quantities decrease accordingly. The IFC states the levels that are permitted per floor in percent of allowable quantities. For example a laboratory on the first floor may have thirty gallons of highly flammable liquids but only 3.75 gallons are permitted for the laboratory located on the fourth floor.

In general, anything done to reduce the event of a fire or reduce the spread of a fire improves the safety in the laboratory. For instance, storing flammables in a proper flammable storage cabinet will reduce the event of a fire. Similarly, installing an automatic fire suppression system (sprinkler system) will reduce the spread of a fire. The use of flammable storage cabinets and sprinkler systems will allow storage of a greater quantity of flammables in the laboratory.

According to the IFC flammables and combustibles are classified according to their fire risk. The lower the flash point and boiling point, the greater the fire risk. Flammables have a flash point of less than 100°F while combustibles have a flash point equal or greater than 100°F. This is further dependent on boiling point.

- Class IA has a flashpoint <73°F (23°C) and a boiling point <100°F (38°C);
- Class IB has a flashpoint <73°F (23°C) and a boiling point ≥100°F (38°C);
- Class IC has a flashpoint ≥73°F (23°C) and a boiling point <100°F (38°C);
- Class II has a flashpoint ≥100°F (38°C) but <140°F;
- Class IIIA has a flashpoint ≥140°F but <200°F;
- Class IIIB has a flashpoint ≥200°F; and
- Aerosol cans that contain ≥21% (by volume) alcohol or petroleum-based liquids are considered Class IA flammables.

As a sign of the future, OSHA issued new regulations in 2012 for “flammable liquids”. These new regulations replaced the term “Class” with “Categories.” Under these new rules “flammable

liquid” means any liquid having a flashpoint at or below 199.4°F (93°C). Flammable liquids are then divided into four categories:

- Category 1 has a flashpoint <73.4°F (23°C) and a boiling point ≤95°F (35°C). In addition, flammable aerosol cans fall in this category.
- Category 2 has a flashpoint <73.4°F (23°C) and a boiling point >95°F (35°C).
- Category 3 has a flashpoint ≥73.4°F (23°C) and ≤140°F (60°C). *When a Category 3 liquid with a flashpoint ≥100°F (37.8°C) is heated within 30°F (16.7°C) of its flashpoint, it is considered a Category 3 liquid with a flashpoint <100°F (37.8°C).*
- Category 4 has a flashpoint >140°F (60°C) and ≤199.4°F (93°C). *When a Category 4 flammable liquid is heated within 30°F (16.7°C) of its flashpoint, it is considered a Category 3 liquid with a flashpoint ≥100°F (37.8°C).*
- *When liquid with a flashpoint >199.4°F (93°C) is heated within 30°F (16.7°C) of its flashpoint, it is considered a Category 4 flammable liquid.*

So, the question becomes, how much can be stored or used in a laboratory space. The following quantities are permitted if the laboratory or storeroom is located on the various floors of a building.

FLOOR LEVEL	MAXIMUM ALLOWABLE PER CONTROL AREA					
	CLASS IA	CLASS IB	CLASS IC	CLASS II	CLASS IIIA	CLASS IIIB
7 <sup>th</sup> Floor or greater	1.5 gallons	6 gallons	6 gallons	6 gallons	16.5 gallons	660 gallons
4 <sup>th</sup> through 6 <sup>th</sup> Floor	3.75 gallons	15 gallons	15 gallons	15 gallons	41.25 gallons	1,650 gallons
3 <sup>rd</sup> Floor	15 gallons	60 gallons	60 gallons	60 gallons	165 gallons	6,600 gallons
2 <sup>nd</sup> Floor	22.5 gallons	90 gallons	90 gallons	90 gallons	247.5 gallons	9,900 gallons
1 <sup>st</sup> Floor	30 gallons	120 gallons	120 gallons	120 gallons	330 gallons	13,200 gallons
Basement	22.5 gallons	90 gallons	90 gallons	90 gallons	247.5 gallons	9,900 gallons
Sub-Basement	15 gallons	60 gallons	60 gallons	60 gallons	165 gallons	6,600 gallons

If the entire building has a fire sprinkler system, the maximum allowable quantities may be increased 100%. Also, if the flammables or combustibles are stored in approved flammable storage cabinets or safety cans, the maximum allowable quantities may be increased by 100%.

Storage becomes a concern whether a chemical is flammable or not. All containers of chemicals must be labeled with contents and hazard warning information, this includes all laboratory containers, manufacturers containers and safety containers. If the container is for waste, it must also be labeled as “hazardous waste.” Containers of flammable liquids five gallon or smaller should be stored in flammable storage cabinets if they are not in safety cans. In fact, the maximum that can be stored outside of flammable storage cabinets or safety cans is five gallons.

Keep flammable and combustible liquids away from strong oxidizing agents, such as nitric or chromic acid, permanganates, chlorates, perchlorates, and peroxides. Keep flammable and combustible liquids away from an ignition source. Remember that most flammable vapors are heavier than air and can travel to ignition sources.

All chemical containers must be in closed containers. This is especially true with flammable liquids stored in refrigerators or freezers. Refrigerators, freezers and other cooling equipment used for storing flammable liquids must be rated for storing such items and prominently labeled as such. Equipment that is IM or UL listed as FLAMMABLE STORAGE or EXPLOSION PROOF must be used for flammable or volatile liquid storage. Flammable storage indicates that flammable materials are isolated from sparks. Explosion-proof indicates that the entire unit is sealed and can be used in explosive atmospheres.

Flammable and combustible liquids should be stored in approved safety containers. Safety containers have a maximum capacity of five gallons, have a spring-closing lid and spout cover and are designed to safely relieve internal pressure when subjected to fire exposure.

UL approved "Flammable Storage" cabinets should be used for limited chemical storage in individual laboratories. Flammable storage cabinets must be properly designed and constructed according to NFPA guidelines and labeled "**FLAMMABLE-KEEP FIRE AWAY.**" According to the IFC, flammable storage cabinets must have self closing doors with a three point latch and a two inch deep pan at bottom to contain spills. A maximum of 120 gallons may be stored in a flammable storage cabinet. However, this means not more than 60 gallons of OSHA Category 1, 2 or 3 flammable liquids, or more than 120 gallons of OSHA Category 4 flammable liquids. Flammable storage cabinets may be constructed of steel or wood (see below for construction requirements). Existing flammable storage cabinets without self closing doors and purchased prior to 2014 are permitted, however, efforts should be made to refurbish the doors with UL approved self closing devices.

- "Fire resistance." Storage cabinets shall be designed and constructed to limit the internal temperature to not more than 325°F. when subjected to a 10-minute fire test using the standard time-temperature curve as set forth in Standard Methods of Fire Tests of Building Construction and Materials, NFPA 251-1969. All joints and seams shall remain tight and the door shall remain securely closed during the fire test. Cabinets shall be labeled in conspicuous lettering, "**FLAMMABLE - KEEP FIRE AWAY.**"
- Metal cabinets must be constructed as follows: the bottom, top, door and sides of cabinet shall be at least No. 18 gauge sheet iron and double walled with 1½ - inch air space. Joints shall be riveted, welded or made tight by some equally effective means. The door shall be provided with a three-point lock, and the door sill shall be raised at least 2 inches above the bottom of the cabinet.
- Wooden cabinets must be constructed as follows: The bottom, sides and top shall be constructed of an approved grade of plywood at least 1 inch in thickness, which shall not break down or delaminate under fire conditions. All joints shall be rabbetted and shall be fastened in two directions with flathead woodscrews. When more than one door is used, there shall be a rabbetted overlap of not less than 1 inch. Hinges shall be mounted in such

a manner as not to lose their holding capacity due to loosening or burning out of the screws when subjected to the fire test.

Venting of safety cabinets is not recommended in general, however, there may be circumstances that may dictate venting. Do not vent these cabinets unless they also contain volatile toxics or odoriferous chemicals. When space allows, store combustible liquids in storage cabinets for flammable liquids. Otherwise, store combustible liquids in the original manufacturer's containers.

Glass, metal, approved plastic containers or safety cans can be used to contain flammable or combustible liquids. Glass containers as large as one gallon may be used.

CONTAINER SIZE FOR FLAMMABLE AND COMBUSTIBLE LIQUIDS IN LABS					
	CLASS IA	CLASS IB	CLASS IC	CLASS II	CLASS IIIA
GLASS	0.5 L (0.12 gal)	1.0 L (0.25 gal)	4.0 L (1.0 gal)	4.0 L (1.0 gal)	20.0 L (5.0 gal)
METAL	4.0 L (1.0 gal)	20.0 L (5.0 gal)	20.0 L (5.0 gal)	20.0 L (5.0 gal)	20.0 L (5.0 gal)
APPROVED PLASTIC	4.0 L (1.0 gal)	20.0 L (5.0 gal)	20.0 L (5.0 gal)	20.0 L (5.0 gal)	20.0 L (5.0 gal)
SAFETY CANS	10.0 L (2.6 gal)	20.0 L (5.0 gal)	20.0 L (5.0 gal)	20.0 L (5.0 gal)	20.0 L (5.0 gal)

Because of the new OSHA regulations for flammable liquids, the following table can be used as a guide:

CONTAINER SIZE FOR OSHA FLAMMABLE LIQUIDS IN LABS				
	CATEGORY 1	CATEGORY 2	CATEGORY 3	CATEGORY 4
GLASS OR APPROVED PLASTIC	1 pint	1 quart	1 gallon	1 gallon
METAL (OTHER THAN DOT DRUMS)	1 gallon	5 gallon	5 gallon	5 gallon
SAFETY CANS	2 gallon	5 gallon	5 gallon	5 gallon

If you compare the two tables carefully, you will notice that five gallon plastic containers are approved for certain uses under the IFC but not under OSHA. In these cases, the stricter rule will take precedence.

Flammable solvents, such as anhydrous diethyl ether, must be stored in an explosion proof or flammable storage refrigerator. A cold box may be used if explosion proof electrical fixtures are installed. Do not store oxidizers with flammable materials in refrigerators or freezers. Oily rags and similar waste must be placed in metal containers with self closing tops. Operations or equipment that create ignition sources, such as open flames, hot plates and other heat elements, must be eliminated from flammable liquid areas. Metal containers must be grounded when transferring solvents from one container to another. Static sparks can start solvent fires. Flammable or combustible liquids in 55 gallon drums must be stored in special storage rooms for flammable liquids.