

<b>University of Pittsburgh Safety Manual</b>	<b>EH&amp;S Guideline Number: 02-003</b>	
Subject: <b>FLAMMABLE AND COMBUSTIBLE LIQUIDS</b>	Effective Date:04/04/2011 Review Date: 06/08/2020	Page 1 of 9

## STORAGE AND HANDLING OF FLAMMABLE AND COMBUSTIBLE LIQUIDS

These guidelines provide requirements for all University faculty, staff, and students using, handling, or storing flammable and combustible liquids. These requirements are established to ensure faculty, staff and students know the physical characteristics of the material used and the protective measures necessary to prevent fire, explosion, or violent reaction.

### 1. Definitions

- 1.1. **Flammable Liquid:** A liquid having a flash point below 100°F (38°C) and a vapor pressure not exceeding 40 psi at 100°F (thus excluding liquefied petroleum gases, liquefied natural gases and liquefied hydrogen). Flammable liquids are subdivided as follows:

**Class IA:** Liquids with a flash point below 73°F (23°C) and a boiling point below 100°F. *Examples:* acetaldehyde, butyne, chloropropylene, dimethyl sulfide, ethyl chloride, ethyl ether.

**Class IB:** Liquids with flash point below 73°F and a boiling point at or above 100°F. *Examples:* acetone, benzene, carbon disulfide, ethyl alcohol, ethyl acetate, gasoline, hexane, isopropanol, methanol, toluene.

**Class IC:** Liquids with a flash point between 73°F and 100°F. *Examples:* amyl alcohol, butyl alcohol, isobutyl alcohol, methyl isobutyl ketone, styrene, turpentine, xylene.

- 1.2. **Combustible Liquid:** A liquid having a flash point above 100°F. Combustible liquids are subdivided as follows:

**Class II:** Liquids with a flash point at or above 100°F and below 140°F (60°C). *Examples:* No. 1, 2 and 3 fuel oils, kerosene, and hexyl alcohol.

**Class IIIA:** Liquids with a flash point at or above 140°F and below 200°F (93°C). *Examples:* aniline, benzaldehyde, butyl cellosolve, nitrobenzene and pine oil.

**Class IIIB:** Liquids with a flash point at or above 200°F. *Examples:* animal oils; ethylene glycol; glycerin; lubricating, quenching, and transformer oils; triethanolamine; benzyl alcohol; hydraulic fluids and vegetable oils.

- 1.3. **Boiling Point:** The temperature at which a liquid's vapor pressure is equal to the atmospheric pressure. Liquids with low boiling points are very volatile.
- 1.4. **Flash Point:** The minimum temperature of a liquid at which sufficient vapor is liberated to form a vapor-air mixture that will ignite and propagate a flame away from the ignition source (flash fire not continuous combustion).

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- 1.5. Flammable (Explosive) Limits/Flammable (Explosive) Range: The terms flammable and explosive are used interchangeably since unconfined vapors mixed in air will burn while confined vapors will produce an explosion. The minimum vapor concentration in air that, when ignited, will propagate a flame is the lower flammable limit (LFL or LEL). The maximum vapor concentration in air that when ignited will propagate a flame is the upper flammable or explosive limit (UFL or UEL).
- 1.6. Vapor Pressure: A measure of the pressure created by a liquid's vapor at a specific temperature. Flammable or combustible liquids with a high vapor pressure at room temperature are more hazardous than liquids with lower vapor pressures because they will produce more flammable vapor without heating.
- 1.7. Vapor Density: The weight of a volume of pure vapor or gas (with no air present) compared to the weight of an equal volume of dry air at the same temperature and pressure. A vapor density figure less than one indicates the vapor is lighter than air. A figure greater than one indicates the vapor is heavier than air.
- 1.8. Fire Area: An area of a building separated from the remainder of the building by construction having a fire resistance at least 1 hour (i.e. a single laboratory area).
- 1.9. Flammable Material Storage Cabinet: A storage cabinet constructed and arranged in accordance with NFPA and International Fire Code standards. Note: Cabinets that are typically located underneath bench tops and fume hoods are not considered approved cabinets unless they are provided with appropriate UL/FM labeling.
- 1.10. Flammable Liquid Storage Room: A room used for the storage of large quantities of flammable and combustible liquids which meets the construction, arrangement and protection requirements of the City of Pittsburgh, NFPA and International Building and Fire Code standards.
- 1.11. Safety Can: A metal container of not more than 5-gallon capacity which is UL/FM Approved and is provided with a flame arrestor, a spring-closing lid and spout cover designed to relieve internal pressure when subjected to fire exposure.
- 1.12. Approved Plastic Container: A plastic container meeting the requirements of and containing products authorized by the U. S. Department of Transportation (DOT) Hazardous Materials Regulations, 49 CFR or by Part 6 of the United Nations Recommendations on the Transport of Dangerous Goods (i.e. UN 1H1 – non-removable head type plastic containers or as authorized by DOT exemption). The 5 gallon "red" container commonly used for ethanol is an example of a container meeting these guidelines.

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## 2. Hazards Description

Flammable liquids are easily ignited and difficult to extinguish. Combustible liquids require heating for ignition and are easier to extinguish. Flammable and combustible liquids produce a high heat release rate once ignited (i.e., fires produce high temperatures in a short period of time), and associated fires spread rapidly.

Vapors from flammable and combustible liquids can be present at room temperature and can form explosive mixtures with air. Some liquids are unstable or very reactive (e.g., burn when exposed to air without an ignition source, susceptible to spontaneous heating, react violently with other materials including water). These characteristics combine to create a significant fire and/or explosion hazard.

Since the vapors generated from flammable liquids are most often heavier than air, they will seek the lowest available level in a building. This movement of vapors can produce potentially dangerous conditions far removed from the actual vapor source. Flammable vapor, if not removed by ventilation, can flow to an ignition source and flash back to the vapor source.

The volatility of the liquid is increased when externally heated at or above its flash point. Overall, an increase in temperature will increase the hazard created by a flammable or combustible liquid by increasing its vapor's flammable range. Due to this, heated Class II and Class III liquids should be subject to all applicable requirements for Class I and Class II liquids respectively.

## 3. General Guidelines for Flammable and Combustible Liquids

- 3.1. The volume of flammable and combustible liquids in a lab, room or location is restricted by University guidelines, and International Fire Codes. EH&S should be contacted regarding any questions or for additional guidance.
- 3.2. Below grade locations should not be used for Class I flammable liquids. If this is unavoidable, EH&S must be contacted for review and guidance.
- 3.3. Volumes of flammable and/or combustible liquids should be kept to the minimum necessary for the work being done. The following guidelines provide the maximum allowable container size and type based on the flammable and/or combustible liquid classification.

Container Type	Liquid Classification and Maximum Container Size				
	IA	IB	IC	II	III
Glass	1 pt (0.5L)	1 qt (1L)	1.3 gal (5L)	1.3 gal (5L)	5 gal (20L)
Metal or Approved Plastic	1.3 gal (5L)	5 gal (20L)	5 gal (20L)	5 gal (20L)	5 gal (20L)
Safety Cans	2.6 gal (10L)	5 gal (20L)	5 gal (20L)	5 gal (20L)	5 gal (20L)

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- 3.4. The use of glass and plastic containers (with the exception of small squeeze bottles) for flammable and combustible liquids should be avoided where possible. If flammable liquids are handled in glass or plastic containers, carriers designed to protect the containers during transit should be used to prevent spillage.
- 3.4.1. Class IA and Class IB liquids can be stored in glass containers of not more than 1.3 gallon (5 L) capacity if the required purity (such as ACS analytical reagent grade or higher) would be affected by storage in a metal container or if the liquid can cause excessive corrosion of the metal container.
- 3.4.2. Many suppliers furnish glass containers with shatter-resistant coatings that offer significant protection from accidental breakage and are recommended for use when hazardous chemicals need to be kept in glass rather than plastic or metal containers.
- 3.5. The combined volume of flammable and combustible liquid containers stored in a single fire area outside of a storage cabinet or flammable liquid storage room should be restricted as follows:
- 3.5.1. Not in Safety Cans: No more than 1 gallon of Class IA; 5 gallons of Class IB or Class IC; and no more than 10 gallons of Class I and Class II combined.
- 3.5.2. In Safety Cans: No more than 2.6 gallons of Class IA; 5 gallons of Class IB and Class IC; and no more than 25 gallons of Class I and Class II combined.
- 3.5.3. Class IIIA liquids should not exceed 60 gallons (230L).
- 3.5.4. Class IIIB liquids should not exceed four, 55-gallon drums. This applies only to mechanical areas containing hydraulic oils, lubricating oils, etc.
- 3.6. Flammable aerosols and unstable liquids should be treated as Class IA liquids.
- 3.7. Flammable and combustible liquids should be segregated and stored separately from incompatible materials such as acids, bases, corrosives and oxidizers.
- 3.8. Empty and partially full containers should be handled and stored like full containers, that is, in an area suitable for flammable liquid storage (e.g., storage room, flammable liquid cabinet). Contact EH&S for proper disposal methods for empty containers.

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#### 4. Storage of Flammable and Combustible Liquids

- 4.1. An approved flammable liquids storage cabinet is required when:
  - 4.1.1. The aggregate volume of Class I and Class II liquids in an individual fire area not in safety cans exceeds 10 gallons.
  - 4.1.2. The aggregate volume of Class I and Class II liquids in an individual fire area in safety cans exceeds 25 gallons.
  - 4.1.3. The aggregate volume of Class IIIA liquids exceeds 60 gallons.
  - 4.1.4. The aggregate volume of Class IIIB liquids exceeds 220 gallons. This applies only to mechanical areas containing hydraulic oils, lubricating oils, etc.
- 4.2. When a cabinet is provided, it shall be used for the storage of all flammable and combustible materials not in immediate use.
- 4.3. Flammable Material Storage Cabinets must be:
  - 4.3.1. UL/FM approved and marked in conspicuous lettering:
 

**“FLAMMABLE – KEEP FIRE AWAY”**
  - 4.3.2. Limited so that the maximum quantity of Class IA liquids is 30 gallons within the cabinet.
  - 4.3.3. Unvented. If venting is required or requested, EH&S must be contacted for a specific evaluation and guidelines.
  - 4.3.4. Equipped with self-closing and self-latching doors if purchased after 2005. If the cabinets were purchased prior to 2005 and came equipped with self-latching door mechanisms, it is recommended that this safety device be maintained as operational.
- 4.4. A maximum of three (3) flammable material storage cabinets shall be located within a single fire area. If additional cabinets are required, EH&S should be contacted for review and guidance.
- 4.5. Approved Flammable Liquid Storage Rooms are constructed and utilized in compliance with the following guidelines:
  - 4.5.1. Containers of Class I and Class II liquids with a capacity greater than 5 gallons.
  - 4.5.2. The quantity of Class III liquids exceeds 330 gallons (the maximum capacity of 3 flammable liquids cabinets).

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- 4.5.3. Walls, floors and ceilings must be constructed of non-combustible materials and have a fire-resistive rating of not less than one hour. In many cases, a 2-hour rating may be necessary.
- 4.5.4. Doorways must be provided with non-combustible liquid-tight raised sills or ramps to contain spilled material.
- 4.5.5. Approved fire doors must be provided and kept closed and latched at all times (or arranged to close automatically in case of fire).
- 4.5.6. The entrance to the room should be labeled in accordance with NFPA 704 – Identification of the Hazards of Materials for Emergency Response. Consult EH&S.
- 4.5.7. Proper ventilation must be provided. Storage and other materials should not obstruct the exhaust ventilation.
- 4.5.8. Heating is restricted to low pressure steam or hot water.
- 4.5.9. Lighting and electrical service must be properly rated for the materials being stored and/or dispensed in the room. Electrical wiring and utilization equipment for Class I liquid storage shall be Class I, Division 2, and electrical wiring and utilization equipment in inside storage rooms used for the storage of Class II and Class III liquids shall be suitable for general purpose.
- 4.5.10. The room should be kept free of compressed gasses, and all combustible materials such as empty boxes, styrofoam shipping containers, plastic supplies and materials, and trash containers.
- 4.5.11. As applicable, automatic detection, fire protection and/or suppression systems are required in new or renovated rooms.
- 4.5.12. A carbon dioxide (CO<sub>2</sub>) type fire extinguisher must be provided within 10 ft. of the door entrance external to a flammable liquid storage room.
- 4.6. Refrigerated Storage of Flammable and Combustible Liquids
  - 4.6.1. Flammable and combustible materials that must be kept cold shall be stored in closed containers in refrigerators, freezers and coolers that are UL approved and rated for flammable material storage. Note that explosion-proof refrigerators are rarely necessary for University research applications. Consult with EH&S for proper refrigeration unit selection.
  - 4.6.2. Modified or retrofitted refrigerators, freezers or coolers or standard domestic refrigerators must not be used.

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## 5. Dispensing and Control of Ignition

- 5.1. Dispensing of Class I liquids to or from containers less than or equal to 5 gallons (20 L) in capacity shall be performed in one of the following locations:
  - 5.1.1. In a chemical fume hood or,
  - 5.1.2. In an area provided with ventilation adequate to prevent accumulations of flammable vapor/air mixtures from exceeding 25 percent of the lower flammable limit or,
  - 5.1.3. Inside a flammable liquid storage room arranged for dispensing Class I flammable liquids.
- 5.2. Dispensing of Class I liquids to or from containers greater than 5 gallons (20 L) shall be performed in one of the following locations:
  - 5.2.1. In a separate area outside the building or,
  - 5.2.2. Inside a flammable liquid storage room arranged for dispensing Class I flammable liquids.
- 5.3. Class I liquids shall not be transferred between conductive containers of greater than 1.3 gallons (5 L) capacity unless the containers are electrically interconnected by direct bonding or by indirect bonding through a common grounding system.
  - 5.3.1. The use of squeeze bottles is currently permitted, since their use greatly reduces spills and the small rate of intermittent discharge through a squeeze bottle's discharge tube has not proven to be a hazard.
- 5.4. The following applies for the dispensing of flammable and combustible liquids from containers greater than 5 gallons (20 L):
  - 5.4.1. For dispensing of Class I flammable liquids, drum pumps should be used. For dispensing of Class II and Class III liquids, self-closing faucets may be used. Use drip cans below faucets with on-side dispensing operations of Class II liquids in areas where the ambient temperature can approach 100°F (38°C). A shallow metal drip pan is acceptable for use with Class II (except as noted) and Class III combustible liquids. The drum pumps, self-closing faucets, and drip cans should be UL/FM Approved.
  - 5.4.2. When dispensing by faucet, the spout or the flexible metal hose MUST be in contact with the containers by a bonding strap or grounding wire cable.
  - 5.4.3. When dispensing by pump, the dispensing hose must be equipped with a ground wire, both to ground the supply and the receiving container.

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- 5.4.4. Rotary pumps must be equipped with proper hoses and grounding straps to the receiving container.
- 5.4.5. Where possible, dispensing from larger to smaller containers should utilize approved safety cans.
- 5.4.6. Provide safety bungs on drums of Class I liquids arranged for upright dispensing with a drum pump that is not equipped with pressure and vacuum relief vents. If ambient temperatures can approach 100°F (38°C), safety bung use should include Class II liquids. Also provide safety bungs on drums of Class II and III liquids arranged for on-side dispensing.

## **6. Heating Equipment for Flammable and Combustible Liquids**

- 6.1. Heating equipment or heating baths with flammable liquids or combustible liquids heated to their flash points shall be placed in a chemical fume hood or shall be vented to a safe location to control vapors.
- 6.2. All unattended electrical heating equipment shall be equipped with a manual reset over-temperature shutoff switch, in addition to normal temperature controls, if overheating could result in a fire or explosion.
- 6.3. Heating equipment with circulation fans shall be equipped with an interlock arranged to disconnect current to the heating element if the fan fails.
- 6.4. Electrically heated constant temperature baths shall be equipped with over-temperature shutoff switches in addition to normal temperature controls, if overheating could result in a fire or an explosion.
- 6.5. Bath containers shall be of noncombustible materials.
- 6.6. Burners, induction heaters, ovens, furnaces, and other heat-producing equipment shall be located a safe distance from areas where temperature-sensitive and flammable materials and compressed gases are handled.

## **7. Safety Considerations**

- 7.1. For all areas using flammable or combustible liquids, CO2 fire extinguishers should be located within a 50 ft. travel distance. Multi-purpose ABC type fire extinguishers are also suitable for use within location and spacing requirements meeting applicable IFC and/or NFPA guidelines.
- 7.2. Eliminate or exclude all sources of ignition within use and storage areas for flammable and combustible liquids.
- 7.3. Spark-proof tools should be used to eliminate friction sparks made by metal striking metal contact.



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- 7.4. Oil or solvent soaked wiping clothes, rags or waste must be stored in an UL/FM Approved metal container with a self closing lid. The containers should be provided with an orange chemical waste sticker (available from EH&S) identifying the contents of the container (e.g. "Oil Soaked Rags").
- 7.5. Users of flammable or combustible liquid should maintain absorbent material to control spills.

## **8. Spills**

- 8.1. Minor Spills of Flammable or Combustible Liquids
- 8.1.1. Extinguish ignition sources.
- 8.1.2. Contain spilled material.
- 8.1.3. Use absorbent material to clean spill.
- 8.1.4. Place clean up material in chemical waste stream following guidelines for safe handling of flammable and combustible liquid found in this document.
- 8.2. Spills of flammable or combustible liquids that are beyond the clean-up capabilities of the persons using the materials shall be handled by the Department of Environmental Health and Safety. Such a spill constitutes emergency response and must be promptly reported to EH&S at 412-624-9505 or University Police at 412-624-2121.