Sandia National Laboratories
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Record of Code Decision

SUBJECT:	Storage, Dispensing, Bonding, and Grounding of Flammable and Combustible Liquids	**DATE:**	May 12, 2011
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GENERAL INFORMATION

Fire and explosion hazards from flammable and combustible liquids exist throughout Sandia National Laboratories. The safe handling of these materials requires a basic understanding of the hazards and the steps needed to minimize them.

A **flammable liquid** is defined as a liquid having a closed cup flash point below 100°F (38°C). Flammable liquids are further categorized into a group known as Class I liquids. The Class I category is subdivided as follows:

Class IA. Liquids having a flash point below 73°F (23°C) and having a boiling point below 100°F (38°C).
Class IB. Liquids having a flash point below 73°F (23°C) and having a boiling point at or above 100°F (38°C).
Class IC. Liquids having a flash point at or above 73°F (23°C) and below 100°F (38°C).

The category of flammable liquids does not include compressed gases or cryogenic fluids.

A **combustible liquid** is defined as a liquid having a closed cup flash point at or above 100°F (38°C). Combustible liquids are further subdivided as follows:

Class II. Liquids having a closed cup flash point at or above 100°F (38°C) and below 140°F (60°C).
Class IIIA. Liquids having a closed cup flash point at or above 140°F (60°C) and below 200°F (93°C).
Class IIIB. Liquids having closed cup flash points at or above 200°F (93°C).

The category of combustible liquids does not include compressed gases or cryogenic fluids.

The flashpoint of a flammable or combustible liquid is defined as the minimum temperature in degrees Fahrenheit at which a liquid will give off sufficient vapors to form an ignitable mixture with air near the surface or in the container, but will not sustain combustion. The flashpoint and boiling point of most flammable and combustible liquids can be found in the Material Safety Data Sheet (MSDS) accompanying the product (or on the CIS website).

Flammable and combustible liquid storage, dispensing, and use is regulated by OSHA (29 CFR 1910.106), the International Fire Code (2006 Edition, Chapter 34), and NFPA 30 (2003 Edition). The following Table 1 summarizes the classifications of flammable and combustible liquids based on their flashpoints and the maximum container size and type allowed. The International Fire Code does not differentiate between virgin or waste flammable or combustible liquids (if the waste is characterized as “ignitable”, then it’s a flammable liquid).

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Table 1

Class	IA	IB	IC	II	IIIA	IIIB
Flash point	Below 73ºF (23ºC)	Below 73ºF (23ºC)	At or above 73ºF (23ºC) and below 100º F (38ºC)	At or above 100ºF (38ºC) and below 140ºF (60ºC)	At or above 140ºF (60ºC) and below 200ºF (93ºC)	At or above 200ºF (93ºC)
Boiling point	Below 100ºF (38ºC)	At or above 100ºF (38ºC)				
Flammability Potential	Extremely High	Very High	High	Moderate	Low to Moderate	Low
Examples of commonly used materials	acetaldehyde ethyl ether pentane methyl formate	acetone benzene ethanol butylamine gasoline methanol isopropanol toluene	butanol chlorobenzene turpentine xylene styrene	formaldehyde hydrazine kerosene acetic acid diesel fuel	cyclohexanol formic acid nitrobenzene butyric acid phenol	hydraulic oil lubricating oil dipropylene glycol
NFPA 704 Diamond Fire Hazard Ranking	**4**	**3**	**3**	**2**	**2**	**1**
MAXIMUM CONTAINER SIZE Glass	1 pint (*500 ml*)	1 quart (*1 liter*)	1 gallon (*4 liters*)	1 gallon (*4 liters*)	1 gallon (*4 liters*)	
Metal or approved plastic	1 gallon	5 gallons	5 gallons	5 gallons	5 gallons	
Safety cans	2 gallons	5 gallons	5 gallons	5 gallons	5 gallons	
Metal drums (DOT)	Contact the Department of Building and Fire Safety	Contact the Department of Building and Fire Safety	Contact the Department of Building and Fire Safety	60 gallons	60 gallons	

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Storage of Flammable and Combustible Liquids

1. Flammable and/or combustible liquids stored in the open in a laboratory work area or inside any building shall be kept to the minimum necessary for the work being done.

2. All flammable and combustible liquids shall be stored in an approved flammable liquids storage cabinet or in a flammable liquid storage room (see "Approved Flammable Liquids Storage Cabinets (FLSCs)" below). Quantities of flammable and combustible liquids not exceeding 10 gallons (38 L) used for maintenance purposes are allowed to be stored outside of an approved flammable liquids storage cabinet or approved flammable liquid storage room.

3. Quantities stored in approved flammable liquids storage cabinets shall be limited to no more than 60 gallons of Class I or II liquids and no more than 120 gallons of Class III liquids. The combined total quantity of liquids in an approved flammable liquids storage cabinet shall not exceed 120 gallons. Please refer to Table 1 for maximum allowable container size for each class.

4. The amount of flammable and combustible liquids shall not exceed the Maximum Allowable Quantity per Control Area (Table 2703.1.1(1) of the International Fire Code). A **control area** is a space within a building that is enclosed and bounded by exterior walls, fire walls, fire barriers and roofs, or a combination thereof having a minimum fire-resistance rating of 1-hour, where quantities of hazardous materials not exceeding the maximum allowable quantities per control area are stored, dispensed, used or handled. Please contact the Department of Building and Fire Safety for assistance in evaluating control areas.

5. Approved flammable liquids storage cabinets shall be used to store ONLY flammable and combustible liquids – no solids or gases are allowed inside a FLSC except for the packaging for the liquids (UL 1275 listing requirements). The flammable and combustible liquids must also be compatible with each other. Refer to the MSDSs for incompatibilities.

6. Flammable and combustible liquids shall not be stored near exit doorways, near stairways, in exit corridors, or in a location that would impede egress from the building in the event of a fire.

7. Flammable aerosols and unstable liquids shall be treated as class I-A liquids. Please refer to Table 1.

8. Materials which will react with water or other liquids to produce a hazard shall be segregated from flammable and/or combustible liquids**.**

9. For storage of Class I flammable liquids in basements, contact the Department of Building and Fire Safety for an evaluation. Class II and IIIA liquids are allowed to be stored in basements, provided that the entire building, including the basement, is equipped with an automatic sprinkler system.

Static Electricity Hazards in the laboratory

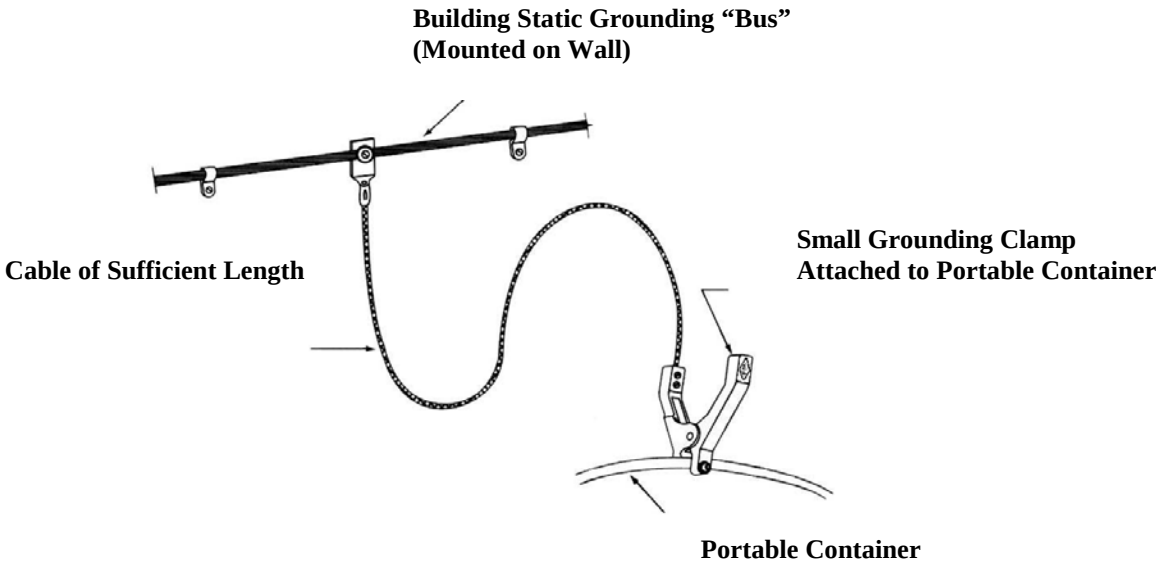
The flow of flammable and combustible liquids can cause the buildup of static electricity. When enough of a charge is built up a spark can result and potentially cause a fire or explosion. The likelihood of this happening is dependent upon how well the liquid conducts electricity, the flash point of the liquid, and the liquid's capacity to generate static electricity.

Static electricity can be generated when liquid is transferred from one container to another. Liquids have the ability to generate static electricity when they move in contact with other materials during pouring, pumping or agitating. The build up of this static electricity can cause a spark to form where the liquid exits the container. This could result in a fire or explosion.

To avoid the build up of static electricity that may cause a spark, it is important to bond and ground metal or special conductive plastic containers. Bonding eliminates the electrical potential between two containers therefore eliminating the likelihood of sparks. A bonding wire is connected to two conductive objects as seen in the drums pictured below.

Bonding wires between drums

Grounding eliminates the difference in static potential charge between the conductive object and ground. Grounding is accomplished by connecting the conductive object directly to the earth, usually using building steel or grounding bus/bar.



Bonding and grounding require good electrical connections. Remove any dirt, paint or rust ensuring **metal to metal** contact.

Bonding and Grounding wires come in a variety of styles and lengths. They can be purchased through our Just-in-Time laboratory supplier.

Hand Clamp

'C' Clamp and Alligator Clip

Static hazards may also exist in non-metallic plastic or glass containers that cannot be grounded. Static may be generated by the free fall and turbulence of the liquid being poured. To minimize this hazard, pour as slowly as possible and use a grounded nozzle extension that allows filling the container from the bottom.

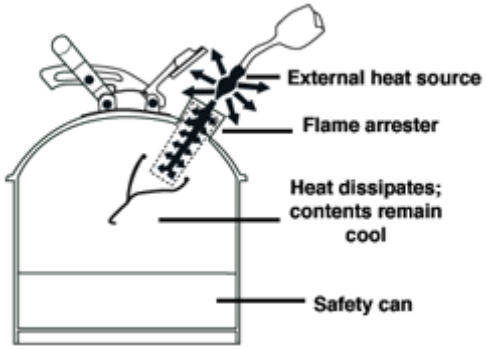
Dispensing Flammable and Combustible Liquids from 5 gallon Cans or Pails

Manual dispensing pumps for 5-gallon cans/pails are available. These pumps are specifically designed to dispense liquids into small laboratory-size bottles without spilling. If you are pouring into a conductive container, a bonding wire should be attached from the 5-gallon can/pail to the container being filled. The 5-gallon can/pail should be grounded.

The dispenser shown in the picture below can be purchased through our Just-in-Time laboratory supplier. The metal strap in the picture hooks over the bottom of the can/pail and secures the dispenser while pumping.

Dispensing Flammable and Combustible Liquids from Safety Cans

Safety cans have self-closing air tight lids and a flame arrester that protects the contents from an external ignition source. Bonding and grounding is still required on safety cans since static electricity generation is possible. The nozzle provides a bonding path to a receiving metallic vessel**.**



If either of the containers is non-metallic (non-conductive) it is still important to follow the limited velocity and grounded nozzle extension information given previously**.**

Safety can with extended nozzle

Safety cans do not offer protection from heat when exposed to fire and should be stored in an approved flammable liquids storage cabinet when not in use.

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Approved Flammable Liquids Storage Cabinets (FLSCs)

Flammable liquids storage cabinets (FLSCs) are constructed to limit the internal temperature when the exterior of the cabinet is exposed to fire. Approved FLSCs are either UL listed or FM approved. All new Flammable Liquids Storage Cabinets (purchased after March 17, 2010) shall be equipped with self-closing and self-latching doors per the requirements of the International Fire Code, Chapter 34. All existing Flammable Liquids Storage Cabinets that do not have self-closing doors shall be equipped with a sign on the exterior of the door stating, “NOTICE: Keep Door Closed and Latched While Not In Use”. Signs can be ordered through SNL’s JIT Contractor, Fastsigns (in the Eubank Center), 292-4444 or 104@fastsigns.com, reference Order Number 104-56759. All containers of flammable and combustible liquids must be stored in a FLSC when not in use.

Flammable liquids storage cabinets shall be marked “Flammable-Keep Fire Away”. FLSCs are not required to be vented, since venting of FLSCs has not been demonstrated to be necessary for fire protection purposes. Additionally, venting a FLSC could compromise the ability of the cabinet to adequately protect its contents from involvement in a fire, because FLSCs are not generally tested with any venting. Therefore, venting of FLSCs is not recommended. Use the bungs supplied with the FLSC to seal the vent openings.

However, it is recognized that some jurisdictions might require FLSCs to be vented and that venting can also be desirable for other reasons, such as health and safety. If this is the case, contact the Department of Building and Fire Safety for consultation.

Flammable liquids storage cabinets are equipped with a grounding system that can be connected to a building ground. If you are pouring from a container in the FLSC and if the container being poured to is conductive, then a bonding strap should be attached between them as explained in ‘Static Electricity Hazards in the Laboratory” section above.

Flammable Liquids Storage Cabinets can be purchased through our Just-in-Time laboratory supplier.

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Citations

1) Office of Environmental Health and Radiation Safety (EHRS), University of Pennsylvania, http://www.ehrs.upenn.edu/resources/docs/labsafety/FS_GroundingBonding.pdf
2) Department of Environmental Health and Safety, University of Utah, http://www.ehs.utah.edu/FlammableLiquid.html
3) NFPA, IFC, OSHA