

# Flammable Liquid Storage

SafetyNet #: 523

## Properties, Classification, Quantities, Cabinets, Containers and Refrigerators

### A. Summary

Flammable and combustible liquid fires are much more volatile than fires fueled by ordinary combustibles, such as wood, paper, and cloth. Flammable vapors ignite with explosive force, and the resulting fire gives off more than twice as much heat as ordinary combustibles. The rate of temperature rise is greater, and burning liquids produce billowing clouds of thick, toxic, black, and acrid smoke. Flammable liquid fires also spread rapidly when spilled material flows into low lying areas, sometimes many feet away from the original spill. Because of these hazards, special precautions are required when storing, handling, and using flammable liquids.

### B. Flammable and Combustible Liquid Classifications

The Occupational Safety and Health Administration (OSHA), the National Fire Protection Association (NFPA), and the California Fire Code (CFC) define flammable liquids as any liquid that has a closed cup flash point of less than 100°F (38° C), and combustible liquids as those that have a flash point greater than 100° F (38° C). These are further categorized into the following subdivisions based on the physical properties of the flashpoint and/or boiling point.

The flash point of a liquid is defined as the minimum temperature at which a liquid gives off sufficient vapor to ignite in the presence of a source of ignition. Remember, it is the vapor that burns and not the liquid.

Flammable Liquids:

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 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).

Combustible Liquids:

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 a closed cup flash point at or above 200° F (93° C).

Classification of Flammable and Combustible Liquids				
Flammable Liquid		Combustible Liquid		
Class 1A Boiling Point < 100 °F	Class 1C	Class II	Class IIIA	Class IIIB
Class 1B Boiling Point ≥ 100 °F				
Flash point < 73 ° F	73 ° F ≤ Flash point < 100 ° F	100 ° F < Flash point < 140 ° F	140 ° F < Flash point < 200 ° F	Flash point ≥ 200 ° F

Properties and NFPA Classification of Common Laboratory Chemicals			
Chemical	Flash Point °F (°C)	Boiling Point	NFPA Classification
Glacial Acetic Acid	103 (39)	245 (118)	II
Acetone	-4 (-20)	133 (56)	1B
Acetaldehyde	-38 (-39)	70 (21)	1A
Acetonitrile	42 (6)	179 (82)	1B
Benzene	12 (-11)	176 (80)	1B
Chloroform	none	143 (62)	none
Cyclohexene	20 (-7)	181 (83)	1B
Dioxane	54 (12)	214 (101)	1B
Ethyl Acetate	24 (-4)	171 (77)	1B
Ethyl Alcohol	55 (13)	173 (78)	1B
Diethyl Ether	-49 (-45)	94 (35)	1A
Formamide	310 (154)	410 (210)	IIIB
Formic Acid	156 (69)	213 (101)	IIIA

Gasoline	-45 (-48)	100-400 (88-204)	1B
Hexane	-7 (-22)	156 (68)	1B
Isopropanol	53 (12)	183 (83)	1B
Methanol	52 (11)	174 (64)	1B
Methylene Chloride	None	104 (40)	none
Methyl Ethyl Ketone	16 (9)	176 (80)	1B
Pentane	57 (14)	97 (36)	1A
Petroleum Ether	-9 (-23)	194 (90)	1B
Phenol	175 (79)	360 (182)	IIIA
Propyl Alcohol	74 (23)	207 (97)	1B
Pyridine	68 (20)	239 (115)	1B
Tetrahydrofuran	6 (-14)	151 (66)	1B
Toluene	40 (4)	230 (111)	1B
Triethylamine	16 (-7)	193 (89)	1B
o-Xylene	63 (17)	291 (144)	1B

Mixtures of soluble flammable chemicals and water also affect the flammable properties of these solutions. The following table summarizes the various properties of ethyl alcohol and water solutions.

Flammable Properties of Ethyl Alcohol Solutions												
Percent Ethyl Alcohol in water	100 %	96%	95%	80%	70%	60%	50%	40%	30%	20%	10%	5%
Flash Point °F (°C)	55 (13)	62 (17)	63 (17)	68 (20)	70 (21)	72 (22)	75 (24)	79 (26)	85 (29)	100 (38)	120 (49)	144 (62)
NFPA Class	1B	1B	1B	1B	1B	1B	1C	1C	1C	II	II	IIIA

### C. Flammable and Combustible Liquid Storage

Flammable liquids shall not be stored in residence halls or in assembly areas, except for small amounts, as

approved by the Campus Fire Marshal.

## 1. Maximum Allowable Quantities

The California Fire Code establishes the maximum allowable quantities (MAQ) of flammable or combustible liquids which are permitted in a control area (laboratory or suite of laboratories). Control areas are limited by the location within the building and the buildings construction specifications. The MAQ defines what the total aggregate volume of liquids can be inside of a particular control area.

The following table shows the MAQs that can be stored in a single fire control area (laboratory or suite of laboratories) per floor.

<b>Maximum Allowable Quantity of Flammable and Combustible Liquids (gallons)*</b>						
Adapted from The 2016 California Fire Code, Table 5003.1.1(1) and Table 5003.8.3.2						
<b>Hazardous Material</b>	<b>Class</b>	<b>Basement# 75% of MAQ</b>	<b>First Floor 100 % of MAQ</b>	<b>Second Floor 75% of MAQ</b>	<b>Third Floor 50% of MAQ</b>	<b>Fourth floor and above 12.5% of MAQ</b>
<b>Flammable Liquid</b>	1A	7.5	30	22.5	15	3.75
	1B and 1C	22.5	120	90	60	15
<b>Combination of Flammable Liquids (1A, 1B, 1C)</b>	1A+1B+1C	22.5	120	90	60	15
<b>Combustible Liquids</b>	II	90	120	90	60	15
	IIIA	440	330	440	165	41.25
	IIIB	9900	13,200	9900	660	1,650

Note: The quantities may be increased 100% when approved flammable cabinet are used, and another 100% if the building is equipped throughout with fire suppression sprinklers. Additional restrictions are placed on the storage of Class 1 flammable liquids stored in basements. It may not exceed the MAQ for use-open systems from Table 5003.1.1(1) providing there is an automatic suppression and other fire protection features in accordance with chapter 9.

- Quantity Limits Outside Flammable Storage Cabinets

No more than ten (10) gallons of flammable or combustible liquids may be stored outside a flammable cabinet.

- Quantity Limits Inside Flammable Storage Cabinets

Flammable liquids stored inside flammable storage cabinets are limited to 60 gallons of Class 1A flammable liquids per cabinet. The total volume of combined classes of flammable and combustible liquids may not

exceed 120 gallons per cabinet.

## **2. Flammable Materials Storage Cabinets**

Flammable material storage cabinets protect flammable and combustible liquids during fires by insulating the liquid containers from heat, and thereby from building excessive internal pressure. The storage cabinets also act to contain spilled flammable liquids which can further spread a fire. All flammable and combustible liquids in excess of 10 gallons in a laboratory must be stored in approved flammable material cabinets. In rooms where 10 gallons or less are stored, flammable cabinets are recommended but not required.

Flammable material cabinets must meet the construction specifications of NFPA 30, and CFC. Cabinets must be Underwriter Laboratories (UL) 1275 listed, which is indicated by a permanent label on the cabinet affixed by the manufacturers. Self-closing doors with a three point latch are required per the CFC, Section 5704.3.2.1.3. Cabinets should be placed so that they do not block or impede egress.

NFPA 30 does not require flammable cabinets to be ventilated. If not vented, the vent openings must be sealed. If vented, the vent openings must be equipped with spark arrestors. The supply and exhaust must be ducted to the outside and the flow must be installed with supply provided at the top and exhaust exiting at the bottom of the cabinet. UC Davis Fire Prevention must approve venting of any flammable storage cabinet. See: [SafetyNet # 519: Venting Flammable Storage Cabinets](#) [1].

Grounding is not required unless Class IA flammable liquids are being dispensed from the cabinet. If grounding is desired, the cabinets must be grounded to a static grounding terminal and not to the ground of an electrical receptacle.

## **3. Storage Containers**

NFPA 30 defines the maximum allowable capacity for containers used in laboratories. Refer to NFPA 30-2015 section 9.4.3 Maximum Allowable Size.

Individual glass containers of Class 1A liquids must not exceed 1 pint (500 mL) capacity. Individual glass containers of Class 1B liquids must not exceed 1 quart (1 L) capacity.

Exception: Class 1A and 1B liquids may be stored in factory-shipped glass containers up to 1- gallon or 4 - liter capacity if the required liquid purity would be affected by storage in metal containers or if the liquid would cause excessive corrosion of a metal container.

Maximum Allowable Container Capacity Adapted from NFPA 30-2015 Table 9.4.3					
Container type	Flammable Liquids			Combustible Liquids	
	Class 1A	Class 1B	Class 1C	Class II	Class IIIA
Glass	1 pt. (500 mL)	1 qt. (1 L)	1.3 gal (5 L)	1.3 gal (5 L)	1.3 gal (5 L)
Metal or approved plastic	1.3 gal (5 L)	5.3 gal (20 L)	5.3 gal (20 L)	5.3 gal (20 L)	5.3 gal (20 L)
Safety Can	2.6 gal (10 L)	5.3 gal (20 L)	5.3 gal (20 L)	5.3 gal (20 L)	5.3 gal (20 L)
Metal Drum	119 gal (450 L)	119 gal (450 L)	119 gal (450 L)	119 gal (450 L)	119 gal (450 L)
Polyethylene	1.3 gal (5 L)	5.3 gal (20 L)	5.3 gal (20 L)	119 gal (450 L)	119 gal (450 L)

#### 4. Flammable Material Storage Refrigerators

Improper storage of flammable liquids in household-type domestic refrigerators can be very dangerous and presents the risk of personal injury and/or property damage. A domestic refrigerator has components located in the refrigerator compartment which are sources of ignition: temperature controls, thermostats, relays, light switches, light assemblies, defrost mechanisms, fans, and even mechanical door latches. The accumulation of flammable vapors inside the confined space of the domestic refrigerator can result in an explosion or fire if these vapors are ignited by one of these ignition sources (see photo below).



#### 5. Domestic Refrigerators/Freezer

Domestic household refrigerators are very useful in the laboratory for storing non-flammable chemicals; however, the internal refrigerator components can create a spark capable of igniting vapors if flammable liquids are stored inside. Domestic refrigerators must be labeled properly and flammable materials must never be stored in this type of refrigerator.



## 6. Approved Flammable Material Refrigerator/Freezer

Approved refrigerator/freezers are designed to prevent ignition of flammable vapors or gases that may be present inside the refrigerator. With this type of unit, the electrical components are located outside of the refrigerated compartment and have to be purchased/used whenever reduced temperatures are needed to store flammable liquids.

There are flammable material refrigerators available which have design features such as thresholds, self-closing doors, magnetic door gaskets, and special inner shell materials that control or limit the damage should a reaction occur within the storage compartment. All flammable material storage refrigerators must be properly labeled and UL listed. Ultra-low freezers (less than -40°F) generally cannot be approved for storage of flammable materials.

Storage of flammable chemicals in approved refrigerated environments requires proper precautions:

- Keep all containers tightly closed.
- No open containers (i.e. open beakers, test tubes, flasks, bottles, or other containers).
- Make sure that the integrity of the container and the lid or stopper is adequate.



## 7. Explosion Proof Refrigerator/Freezer

Explosion-proof refrigerators are designed to prevent ignition of flammable vapors or gases that may be present inside and outside of the refrigerator. This type of refrigerator is needed in locations such as solvent dispensing rooms, where a flammable atmosphere may develop at some time in the room. Explosion-proof refrigerators have very limited use and require special hazardous-location wiring rather than the simple plug-in type power cord.

\*Consult with UC Davis Fire Prevention Services (530 752-1493) before purchasing an explosion proof refrigerator.

## Contact

### Fire Prevention Services

fireprevention@ucdavis.edu 530-752-1493

### More information

<https://safetyservices.ucdavis.edu/fire-prevention-staff-listing> [2]

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### Links

[1] <http://safetyservices.ucdavis.edu/safetynet/venting-flammable-storage-cabinets>

[2] <https://safetyservices.ucdavis.edu/fire-prevention-staff-listing>