



FACT SHEET

Program: Lab Fire Safety

REFRIGERATION/FREEZING OF FLAMMABLE LIQUIDS

Fires and explosions can and do occur in either general-purpose laboratory or ordinary domestic refrigerators or freezers when these types of appliances are used to store volatile or flammable materials.

There are basically three different types of refrigerators/freezers:

1. **Household (Domestic):** Refrigerators and freezers that can be used in school science laboratories for storage of aqueous solutions and **nonflammable/non-explosive materials.**
2. **Lab-Safe (Flammable Safe):** Refrigerators and freezers which are used for storage of **flammable or explosive materials.** This type of cooling technology has no internal switching devices that can arc or spark as a source of ignition. The compressor and other circuits usually are located at the top of the unit to reduce the potential for ignition of floor-level flammable vapors. These refrigerators also incorporate design features such as thresholds, self-closing doors, and magnetic door gaskets. Special inner shell materials control or limit damage should an exothermic reaction occur within the storage compartment.
3. **Explosion-Proof: Refrigerators that are designed to be operational in areas where the air outside the refrigerator might be explosive.** This often includes liquids, gases, or solids with flashpoints of less than 100°F.

Explosion-proof refrigerators feature enclosed motors to eliminate sparking and bear a FM® (Factory Mutual) or UL® (Underwriters Laboratory) explosion-proof label.

Such refrigerators must meet the requirements for Class 1, Division 1 Electrical Safety Code (NFPA 45 and 70) and require direct wiring to the power source via a metal conduit. **These units are not common in laboratories.**

REFERENCES: NFPA 45 - 12.2.2 Refrigeration and Cooling Equipment.

Flammable solvents have very low flashpoints and flammable limits (lowest vapor concentration that can be ignited with a spark), so a normal refrigerator does not provide safe storage for them.



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Ordinary refrigerators commonly have many sources of ignition (e.g., thermostat, interior light, light switch on the door, defrost heater, defrost control switch, the compressor unit, and the fan). The ignition sources have ignited trapped vapors from poorly sealed or broken containers and caused harmful lab explosions.

Lab-Safe Refrigerator

All the electrical components in this type of refrigerator are outside the refrigerator, and the compressor is sealed or located at the top of the unit. Flammable material refrigerators also may incorporate 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. A label stating

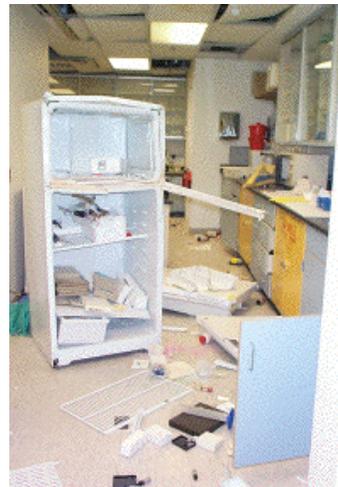
"Flammable Materials Refrigerator: Keep fire away" can identify such refrigerators. The refrigerators must be U.L. Listed as Flammable Material Storage Refrigerators.

Explosion-proof refrigerators are designed to prevent ignition of flammable vapors or gases that may be present **outside** the refrigerator. This type of refrigerator must be used 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 on campus and require special hazardous-location wiring rather than simple cord-and-plug connections.**

Why Purchase a Lab-Safe Refrigerator/Freezer?

A university laboratory experienced an explosion and fire resulting from the temporary storage of solution samples (alcohol / ethanol etc.) in a non-laboratory safe refrigerator. The amount of materials placed in the refrigerator was very small. One laboratory was conducting some house cleaning and an individual placed the solutions in another laboratory's refrigerator thinking it was lab safe refrigerator. Fortunately, no one was in the lab when the explosion occurred.

The loss due to the explosion, fire and smoke was around \$200,000 in addition to the time the laboratory was unable to be used during renovation and cleanup.





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PREVENTING EXPLOSIONS

To prevent refrigerator and freezer explosions,

1. **All materials with a flashpoint below 100° F (38°C) may ONLY be stored in a UL approved flammable materials storage refrigerator or freezer.** These units do not have any internal ignition sources.
2. **All ordinary domestic refrigerators and freezers** should be labeled with the phrase "No materials with a flashpoint below 100° F (38°C) may be stored in this refrigerator/ freezer" or "**Not for flammable storage.**"

Flammable material refrigerators and freezers are designed to prevent ignition of flammable vapors inside the storage compartment and should be purchased whenever a refrigerator is needed to store flammable liquid.

A flammable liquid is defined by the fire code as having a flash point of less than 100 °F (38°C). *Some examples of common flammable liquids are listed at the end of this fact sheet.*

Safety Hazards:

- Domestic or general-purpose laboratory refrigerators and freezers can contain up to nine arcing points in the storage compartment. Each produces electrical arcs or sparks during the normal course of operations. The arc produced at the arc points will ignite flammable vapors emitted from damaged or unsealed containers. In addition, the compressor and its circuits are typically located at the bottom of the domestic unit where vapors from flammable liquid spills or leaks in the storage compartment may easily accumulate.
- The compressor unit for domestic units is not vapor-proof; therefore, arc points inside the compressor pose the identical hazard as described above. In contrast, all commercial laboratory refrigerators and freezers are equipped with fully vapor sealed or semi-sealed compressors.



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Common Laboratory Solvents

Do not store these flammable or any other flammable liquids (diluted in water if concentration by volume is noted) in domestic refrigerators. A flammable liquid has a flash point **below 38°C or 100°F**. See the Material Safety Data Sheet for the flash point of other liquids or other dilute concentrations of the liquids below.

Chemical	Flash point		Chemical	Flash point	
	°C	°F		°C	°F
Acetone	16	4	Isopropanol	12	53
Acetonitrile	6	42	Methanol	12	54
Benzene	-11	12	Methanol (35%)	35	95
Butanol	29	84	Petroleum Ether	-7	20
Cyclohexene	-12	10	Propyl Alcohol	23	74
Dioxane	12	54	Pyridine	20	68
Ethyl Acetate	-4	24	Tetrahydrofuran	-14	6
Ethyl Alcohol	13	55	Tetramethyl- ethylenediamine	10	50
Ethyl Alcohol (20%)	36	97	Toluene	4	40
Ethyl Ether	-45	-49	Triethylamine	-7	20
Hexane	-22	-7	Xylene	29	84

Flammability Classifications for Common Laboratory Chemicals:

Class IA	Class IB	Class IC
Dimethyl Sulfide	Acetone	Ethylene Glycol Diethyl Ether
Ethylene Oxide	Acrylonitrile	Ethylene Glycol Isopropyl Ether
Ethyl Mercaptan	Ethyl Acetate	Hydrazine
Hydrogen Cyanide	Ethyl Alcohol (Ethanol)	High Flash V.M.&P. Naphtha
Pentane	Ethylene Dichloride	Paraldehyde
Petroleum Ether*	Ethyl Ether	Styrene



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Class IA	Class IB	Class IC
Propylene Oxide	Heptane	Xylenes
Vinyl Chloride	Hexane	Butyl Alcohol
Acetaldehyde	Isopropanol	Butyl Aceylate
2-Butyne	(Methyl Alcohol) Methanol	M-Xylene
2-Chloropropane	Methyl Ethyl Ketone	O-Xylene
Dichlorosilane	Methyl Isobutyl Ketone	P-Xylene
Methyl Ethel Ether	Methyl Methacrylate	Amyl Alacohol
Methyl Formate	Petroleum Ether*	Amyl Bromide
Methyl Mercaptan	V.M.&P Naphtha	Butyl Nitrate
Cimethyl Sulfide	Pyridine	Chlorobenzene
Ethyl Amine	Tetrahydrofuran	Cumene
Ethyl Chloride	Toluene	Cyclohexanone
Ethyl Nitrite	p-Dioxane	Dibutyl Ether
Furan	Ethyl Nitrate	Hexylamine
Hydrocyanic Acid	Methyl Isobutyl Ketone	Isoamyl Acetate
Isoprene	Methyl Methacrylate	Isobutyl Alcohol
1, 3 Pentadiene	Octane	Nitromethane
Trichlorosilane	Triethylamine	Turpentine

REFERENCES:

National Fire Protection Association - NFPA 45

12.2.2 Refrigeration and Cooling Equipment.

[Prudent Practices in the Laboratory – Handling and Management of Chemical Hazards \(2011\)](#) - Chapter 7 (Working with Laboratory Equipment)

7. c.3 Refrigerators and Freezers.

CRC Handbook of Laboratory Safety: Fifth Edition (CRC Handbook of Laboratory Safety, 5th Ed) by A. Keith Furr.