Appendix E1
Safe Storage and Handling of Flammable and Combustible Liquids

Flammable and combustible liquids are extremely hazardous because:

- They can be easily ignited and release heat at a much faster rate compared to a fire in ordinary combustible materials.
- Some flammable liquids produce flammable vapor-air mixtures at normal room temperatures.
- They can spread over large areas from a leaking container or an accidental spill.
- When stored in closed containers the vessels can rupture or even explode if subjected to heat from internal buildup of pressure.
- Improper handling, storage, and dispensing can result in fires or explosions.
- Inadequate or improper ventilation can cause vapors to accumulate in an open space or area and can easily can be ignited, resulting in a fire or explosion.
- Fires involving flammable or combustible liquids can release toxic vapors.

Key property risk control measures to be established to ensure safe storage and handling of flammable and combustible liquids include at least:

- Identification
- Container Requirements
- Storage Cabinet Requirements
- Inside Storage Room Requirements
- Storage Outside Buildings
- Fire Control
- Separation and Protection
- Transfer and Handling
- Bonding and Grounding

Identification

Tips for identifying flammable and combustible liquids include:

- Container label shows flash point less than 100ºF for flammable liquids and 100ºF or higher for combustible liquids. Label may also have other information on flammability and reactivity of the liquid.
- Material Safety Data Sheets provide information on flammability, combustibility and other chemical hazards.
- Diamond shaped labels or placards on bulk shipments, drums or containers show the words FLAMMABLE or COMBUSTIBLE.
- Diamond shaped label on container shows degree of flammability or combustibility using the following numeric rating system based on NFPA 704 Standard System for the Identification of the Fire Hazards of Materials

  0 = no flash point / noncombustible

  1 = Flash Point > 200ºF

  2 = Flash Point from 73ºF to 200ºF

  3 = Flash Point < 73ºF, Boiling Point > 100ºF

  4 = Flash Point < 73ºF, Boiling Point < 100ºF

To understand the difference between a flammable and a combustible liquid and how they are classified based on physical properties refer to Table I below.

Table I
Classification - Flammable and Combustible Liquids

Class IA	Flammable	below 73ºF	below 100ºF
Class IB	Flammable	below 73ºF	at or above 100ºF
Class IC	Flammable	at or above 73ºF	below 100ºF
Class II	Combustible	at or above 100ºF	below 140ºF
Class IIIA	Combustible	at or above 140ºF	below 200ºF
Class IIIB	Combustible	at or above 200ºF	N/A

Container Requirements

Container requirements pertain to liquid in drums or other containers that do not exceed 60 gallons capacity and in portable tanks that do not exceed 660 gallons capacity. For maximum allowable container sizes refer to Table II below. Other major areas of concern are:

- Only US Department of Transportation (DOT) approved containers and portable tanks should be used.
- NFPA 30, Flammable and Combustible Liquids Code, specifies that portable tanks must be metal.
- In general, if the product is in the manufacturer's original shipping container, you should be able to assume that it is approved under DOT rules. If you suspect otherwise, then refer to CFR Title 49, Transportation Part 177.

Table II
Maximum Allowable Container Sizes

	Flammable Liquid Class			Combustible Liquid Class	
Type of Container	**IA**	**IB**	**IC**	**II**	**III**
Glass	1 pt	1 qt	1 gal	1 gal	5 gal
Metal or UL listed or FM approved plastic Safety Cans	1 gal	5 gal	5 gal	5 gal	5 gal
Safety Cans-metal	2 gal	5 gal	5 gal	5 gal	5 gal
Metal Drum (DOT)	60 gal	60 gal	60 gal	60 gal	60 gal
Approved Portable Tanks	660 gal	660 gal	660 gal	660 gal	660 gal

Storage Cabinet Requirements

- Flammable liquids storage cabinets should be Underwriters Laboratories (UL) listed or Factory Mutual (FM) approved.
- Cabinets should be provided where it is necessary to keep more than 25 gallons of flammable liquid inside a building.
- Generally, not more than 60 gallons of flammable or combustible liquids should be stored in a single cabinet.
- If the flash point is greater than 140ºF, then you may store up to 120 gallons in a single cabinet.
- No more than three storage cabinets in any one fire area, unless there is a 100' separation between additional cabinets, (maximum of three per group). If the building is protected by an automatic sprinkler system installed in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems, the number of cabinets in any one fire area can be increased to six.
- Cabinets should be labeled in conspicuous lettering **"FLAMMABLE - KEEP FIRE AWAY."**
- Cabinets should be provided with a sill raised at least 2 inches above the bottom of the cabinet to retain spilled liquids.
- Cabinets are provided with capped vent openings equipped with fire baffle screens.
- If the storage cabinet is vented it should be safely ventilated to the outdoors.

Inside Storage Room Requirements

- If the building is not sprinklered, flammable or combustible liquids must be kept in storage rooms when quantities of flammable or combustible liquids stored inside exceed 180 gallons. This quantity may be doubled if the building is sprinklered.
- Inside storage rooms should be constructed to meet at least the requirements shown in Flammable Liquids Storage Room Requirements (Appendix E2).
- In every inside storage room there should be maintained one clear aisle at least 3 feet wide.
- Containers over 30-gallon capacity should not be stacked one upon the other.
- Dispensing of liquids should be done by using an approved pump or self-closing faucet only.

Other General Requirements for Storage Buildings

- No more than one day's supply of flammable or combustible liquids should be kept outside a flammable liquids storage cabinet or an inside storage room.
- Flammable or combustible liquids, including stock for sale should not be stored so as to limit the use of exits, stairways and other means normally used for the safe egress of people.
- Storage should be prohibited in office occupancies except that amount required for normal maintenance of the building and operation of office equipment.
- All incidental storage should be kept in UL listed safety cans.

Storage Outside Buildings

- Storage should be in accordance with the tables shown in NFPA 30, Flammable and Combustible Liquids Code. Refer to Table III for details.
- A maximum of 1100 gallons (twenty-55 gallon drums) of flammable or combustible liquids may be stored adjacent to a building.
- When the quantity stored exceeds 1100 gallons, maintain a minimum distance of 10 feet between the buildings and the nearest containers of flammable or combustible liquids.
- The storage areas should be constructed and laid out in a manner to divert possible spill away from buildings or other exposures or to contain them.
- The storage area should be protected against tampering or trespassers.
- The storage area should be kept clean and free of weeds, debris and other combustible material.
- Open flames and sources of spark generation (i.e. cutting and welding) should be strictly prohibited in flammable and combustible liquids storage areas.
- "NO SMOKING" signs should be posted and this rule strictly enforced.

Table III
Outdoor Storage

Class	Container Storage		Portable Tank Storage		Distance Between Piles/Racks	Distance to Property Line	Distance to Road
1A	1,100	10	2,200	7	**(ft)**	**(ft)**	**(ft)**
1B	2,200	12	4,400	14	5	50	10
1C	4,400	12	8,800	14	5	50	10
II	8,800	12	17,600	14	5	50	10
III	22,000	18	44,000	14	5	50	5
1A	1,100	10	2,200	7	5	10	5

Fire Control

- Suitable fire control devices, such as portable fire extinguishers or standpipe with hose systems should be available at locations where flammable or combustible liquids are stored. Refer to Portable Fire Extinguishers section in this manual for more information.
- At least one portable fire extinguisher with a rating of at least 20-B should be located not less than 10 feet nor more than 25 feet away from any flammable or combustible liquids storage area located outside a storage room but inside a building.

- Organic Peroxides are strong oxidizing agents and fire hazards when in contact with combustible materials and reducing agents, especially under high temperature conditions. Therefore, they should stored separately from flammable and combustible materials.

Separation and Protection

- Areas in which flammable or combustible liquids are transferred from one tank or container to another should be separated from other operations in the building by adequate distance or by construction having adequate fire resistance.
- Drainage or other means should be provided to control spills.
- Adequate natural or mechanical ventilation should be provided.

Transfer and Handling

- Flammable liquids should be kept in UL listed safety cans and covered when not in use.
- Methods should be developed, posted, and distributed which describe how to safely and promptly dispose of leakage and spills.
- Employees should be trained in hazardous waste operations, if applicable.
- Flammable liquids may be used only where there are no open flames or other sources of ignition within the possible path of vapor travel.
- Flammable or combustible liquids should be drawn from or transferred into vessels, containers or portable tanks within a building only through a closed piping system, from UL listed safety cans, by means of a device drawing through the top or from a container or portable tank by gravity through an approved self-closing valve.
- Transfer by means of air pressure on the container or portable tank should generally be discouraged.

Bonding and Grounding

Static electricity has caused many serious fires from unsafe transfer and handling of flammable liquids. Static sparks will readily ignite flammable vapors. Static electricity can be formed from liquids when they flow through or from pipes or hose, when they fall through the air in drops or as a spray, when they are splashed around in tanks or when air or other gases are bubbled through them. Static electricity and the accumulation of static charges should be controlled through proper bonding and grounding.

Bonding is the process of electrically connecting two or more conductive materials with a copper wire or other conductor. Bonding minimizes electrical potential differences between conductive objects. The conductor ensures that no spark discharge occurs because the bonded objects eventually lead to a ground.

Grounding is the process of electrically connecting one or more electrically conductive objects to the ground or earth. Grounding minimizes electrical potential differences between the objects and earth. Steel rods or metallic water pipes can often be used for grounding.

The bond or ground connections should be composed of suitable conductive materials having adequate mechanical strength, corrosion resistance and flexibility for the service intended. Almost any conductor size will be satisfactory for grounding and bonding purposes. The conductor should be solid for fixed connections or flexible for bonds which are frequently connected or disconnected. The conductor may be insulated for mechanical protection or uninsulated. Connections should be made with pressure type ground clamps, brazing or welding. Some other clamps, such as battery or magnetic clamps may also be needed to provide metal-to-metal contact. Safeguards to take for effective grounding and bonding are:

- Flammable liquids should not be dispensed into containers unless the nozzle and container are electrically interconnected.
- The metallic floor plate on which the container stands while filling should be electrically connected to the fill stem or the fill stem should be bonded to the container during filling operations by means of a bonding wire, as described above. Refer to Bonding and Grounding of Flammable Liquids (Appendix E3) for a diagram of proper set-up.

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