A. FLAMMABILITY HAZARDS

In planning for the safe use and storage of flammable materials it is useful to understand the established nomenclature. Flammable liquids are divided into several classes based on the degree of hazard.

### CLASSES OF FLAMMABLE AND COMBUSTIBLE LIQUIDS

<table>
<thead>
<tr>
<th>CLASS</th>
<th>BOILING POINT</th>
<th>FLASH POINT</th>
<th>EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammable 1A</td>
<td>&lt;37.8 (100)</td>
<td>&lt;22.8 (73)</td>
<td>ethyl ether, pentane</td>
</tr>
<tr>
<td>Flammable 1B</td>
<td>≥37.8 (100)</td>
<td>&lt;22.8 (73)</td>
<td>acetone, ethyl alcohol</td>
</tr>
<tr>
<td>Flammable 1C</td>
<td>-</td>
<td>22.8 (73) ≤ and &lt;37.8 (100)</td>
<td>butanol, isoamyl acetate</td>
</tr>
<tr>
<td>Combustible 2</td>
<td>-</td>
<td>37.8 (100) ≤ and &lt;60 (140)</td>
<td>formalin, cyclohexanone</td>
</tr>
<tr>
<td>Combustible 3A</td>
<td>-</td>
<td>60 (140) ≤ and &lt;93.3 (200)</td>
<td>phenol, dichlorobenzene</td>
</tr>
<tr>
<td>Combustible 3B</td>
<td>-</td>
<td>≥93.3 (200)</td>
<td>ethylene glycol, mineral oil</td>
</tr>
</tbody>
</table>


There are a number of important definitions in the evaluation of fire hazard.

**Flammable Solid** - a non-explosive material that is capable of producing fire as a result of friction, water exposure, air exposure or retained heat from synthesis or processing, or when ignited burns so vigorously and persistently so as to create a hazard

**Flammable Gas** - gases of which mixtures in air of 13 percent or less, by volume, forms a flammable mixture; or the flammable range (explosive range) in air is wider than 12 percent regardless of the lower limit (U.S. Department of Transportation definition)

**Boiling point** - the temperature at which the vapor of the liquid is in equilibrium with atmospheric pressure : the lower the boiling point the greater the fire hazard

**Flash point** - the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid - also applies to certain solids that evaporate or volatilize : the lower the flashpoint the greater the fire hazard

**Auto Ignition Temperature** - the minimum temperature that will initiate a self-sustained combustion of liquid, gas or solid in the absence of a spark or flame: the lower the auto ignition temperature the greater the fire hazard
V(d) CHEMICAL SAFETY -- FLAMMABLE CHEMICALS

**Flammable or Explosion Limits** - the range of concentration of a gas or vapor in air, by volume percent in air, in which a fire or explosion can occur upon ignition in a confined area: the larger the range of the explosion limits the greater the fire hazard.

**Vapor Density** - the weight of a volume of pure vapor or gas compared to the weight of an equal volume of dry air at the same temperature and pressure: vapor densities greater than one indicate the vapor or gas is heavier than air.

Information on these physical characteristics of flammable chemicals is listed on manufacturer's container labels and on Material Safety Data Sheets.

For a fire to occur, three conditions must be met:

1. the concentration of the flammable vapor must be between the lower and upper flammable limits,
2. an oxidizing agent (e.g., the air in the room or a chemical oxidizer) must be available, and
3. there must be a source of ignition or the material at its auto ignition temperature.

**B. STORAGE AND DISPENSING**

**Stockroom Storage**

All flammable and combustible chemicals stored in stockrooms must be located in flammable storage cabinets, safety cans or the specially designed solvent storage rooms. Access to ethyl alcohol is controlled by the Laboratory Director in Chemistry and a designated individual in Biology.

**Bulk Dispensing of Flammable Liquids**

All bulk dispensing (from 5 or 55 gallon containers) of flammable liquids must be done in the solvent room. Only faculty, staff, or students specifically trained by the faculty may dispense these solvents. These solvents can only be dispensed into approved (Underwriters Lab or Factory Mutual) flammable safety cans equipped with spring loaded covers and flame arresters, with the sole exception being when contamination from the metal container is a concern. The drum must be grounded and the container bonded (connection between the drum and safety can) to prevent accumulation of static electricity. The drums must be equipped with a self closing faucet or pump approved for flammable dispensing.
Laboratory Storage

The quantity of flammable chemicals, liquids, solids and gases, stored in laboratories should be kept at an absolute minimum. If chemicals are purchased in multiple lots for future use, excess containers should be stored in the solvent storage room or a flammable storage cabinet until needed.

For those flammables which must be stored in the laboratory the preferred storage method is in flammable storage cabinets meeting NFPA standards for liquids or solvents or in UL or FM approved flammable safety cans. Storage in flammable storage cabinets should not exceed the rated capacity of the cabinet. See Chapter V(f) for a discussion of storage of compressed gases.

Under NFPA Standard #45, a limited quantity of flammable liquids can be stored in the laboratory, in addition to that stored in flammable storage cabinets and safety cans. No containers larger than a 5 gallon capacity may be stored in the laboratory.

<table>
<thead>
<tr>
<th>Lab Type</th>
<th>Liquid Class</th>
<th>Per 100 ft²-floor space</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional</td>
<td>1A, 1B, 1C total</td>
<td>1 gallon</td>
</tr>
<tr>
<td></td>
<td>1A-C, 2, 3A total</td>
<td>1 gallon</td>
</tr>
<tr>
<td>All Other (NFPA Class C)</td>
<td>1A, 1B, 1C total</td>
<td>2 gallons</td>
</tr>
<tr>
<td></td>
<td>1A-C, 2, 3A total</td>
<td>4 gallons</td>
</tr>
</tbody>
</table>


If refrigeration of volatile flammable chemicals is required, the refrigerator or freezer must meet NFPA Standards for flammable storage. Flammable materials refrigerators and freezers have spark free interiors. Explosion-proof units also have spark free exteriors and are designed for use in hazardous environments. All units designed for flammable storage should be clearly marked as "approved for flammable storage". All units not approved should be clearly marked "not for flammable storage" or other similar wording.
C. LABORATORY USE

All laboratory procedures using flammable chemicals should be designed to

* minimize the release of flammable vapors,

* prevent the travel or accumulation of vapors,

* eliminate sources of ignition, and

* minimize the amount of flammable chemical or other combustible materials (e.g., paper) in the vicinity of the handling area.

The following precautions should always be followed. These precautions do not apply to the use of natural gas as a fuel for combustion. Additional precautions may be necessary in certain situations.

1. Use flammable liquids in fume hoods whenever possible, particularly when transferring large quantities or heating in open containers.

2. Always use flammable gases in a fume hood.

3. Never use open flames in the same room where flammables are being used.

4. Control other sources of ignition and heat in the laboratory such as electric motors and ovens in areas where flammable vapors are expected to exceed 10% of the lower flammability limit.

5. Use non-sparking equipment and control static electricity.

6. Use steam baths, heating baths, or explosion proof heating equipment for heating.

7. When transferring flammable liquids in metal containers, ground and bond the containers.

8. Minimize the generation of dust when handling flammable solids.

The Chemical Hygiene Officer can assist in evaluating the hazards of particular operations or experiments.