Chemical Compatibility: Hazards and Solutions

This safety guideline provides information on the minimum safety measures Cal Maritime expects all of its Employees and Contractors to follow while handling chemicals. The intent of this guideline is to prevent injuries and damage to property that could occur due to improper storage.

**Introduction**

Perhaps the single most important rule of chemical storage is to segregate incompatible chemicals to prevent accidental mixing which could cause fire, explosion, or toxic gases.

Hazardous chemical reactions can occur from improper storage when incompatible materials mix because of:

- Accidental breakage
- Container failure
- Fires and earthquakes
- Mixing of gases or vapors from poorly closed containers
- Mistakenly storing incompatibles together because of improperly labeled containers

**Chemical compatibility groups**

Store chemical groups below separately from one another, either in separate cabinets or in appropriate tubs or secondary containers. Clearly and legibly label each container and storage location to indicate its compatibility group.

<table>
<thead>
<tr>
<th>Flammable liquids</th>
<th>Liquid oxidizers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressed gases</td>
<td>Non-volatile liquid poisons</td>
</tr>
<tr>
<td>Volatile poisons</td>
<td>Metal hydrides and pyrophorics (air or water reactive)</td>
</tr>
<tr>
<td>Acids</td>
<td>Dry solids</td>
</tr>
</tbody>
</table>

- **Flammable liquids** (flashpoint <100°F) — Examples: All alcohols, acetone, acetaldehyde, acetonitrile, amyl acetate, benzene, cyclohexane, dimethylchlorosilane, dioxane, diethyl ether, ethyl acetate, histoclad, hexane, hydrazine, methyl butane, picolene, piperedine, pyridine, some scintillation liquids, all silanes, tetrahydrofuran, toluene, triethylamine, and xylene
- **See Flammable and Combustible Liquids Storage Plan** for proper storage details. Flammable liquids may be stored with volatile poisons or liquid bases, but **not with both** bases and poisons.
- **Compressed gases** — Examples: Oxygen, nitrogen, hydrogen, arsenic, and acetylene
  - Store securely mounted.
  - Segregate oxygen from flammable gases.
  - Store acutely toxic and toxic gases in gas cabinets or fume hoods
- **Volatile poisons** — Examples: Poisons, toxics, and carcinogens, such as carbon tetrachloride, chloroform, dimethylformamide, dimethyl sulfate, formamide, formaldehyde, halothane, mercaptoethanol, methylene chloride, and phenol
  - Store in a ventilated cabinet.
  - May be stored with flammable liquids if bases are not present.
- **Acids** — Important: Segregate acids from chemicals which could generate toxic or flammable gases upon contact (e.g., cyanide salts, metal sulfides, calcium carbide) and reactive metals (e.g., sodium, potassium, magnesium).
  - Store in a ventilated corrosive storage cabinet if possible.
  - Corrosive to living tissue.
  - Corrosive to metal surfaces.
  - Store in non-corrosive secondary container (e.g., appropriate sized plastic tub).
  - Avoid contact with bases!
- **Mineral acids:**
  - Oxidizing — Examples: Sulfuric, nitric, chromic, perchloric
  - Store separately from organic acids.
  - Highly reactive with most substances, these acids must be double contained (i.e., the primary container must be kept inside a non-corrosive canister, tray, or tub).
  - Perchloric acid presents special hazards. Carefully isolate it from acetic anhydride, bismuth and its alloys, alcohol, paper, wood, oil, ether, grease, and sulfuric acid.
  - Take special precautions to keep perchloric acid away from acetic acid.
- **Non-oxidizing** — Examples: Hydrochloric, hydrofluoric, phosphoric, hydroiodic
  - Hydrofluoric acid (HF) is particularly hazardous and must be handled carefully. HF is a high hazard chemical.
- **Organic acids** — Examples: Acetic, butyric, formic, propionic
Flammable & Combustible Storage: Hazards and Solutions for Campus Laboratories

California Fire Code (CFC) regulations limit the quantity of flammable and combustible liquids that can be stored in research and teaching laboratories. This fact sheet provides a simplification of the complicated CFC regulations, and establishes standard practice at California State University Maritime Academy (Cal Maritime). For questions not covered in this fact sheet, or for assistance with more complicated issues, please contact the Department of Safety and Risk Management for guidance.

Quantity Limits outside Flammable Liquid Storage Cabinets

For each room, no more than a total of 10 gallons of flammable or combustible liquids may be outside a flammable liquid storage cabinet (with the exception of materials stored in approved safety cans).

Quantity Limits inside Flammable Liquid Storage Cabinets

Flammable liquids stored in cabinets meeting applicable requirements (see next section) must not exceed 60 gallons total for Class I-A flammable liquids, per cabinet. In addition, the total volume of all classes of flammable and combustible liquids in any one cabinet must not exceed 120 gallons.
Flammable Liquid Storage Cabinets
Cabinets purchased new must meet the requirements of the CFC or National Fire Protection Association Flammable and Combustible Liquids Code (NFPA 30). The cabinets must be purchased with the self-closing door option to comply with these requirements.

“Flame Safe” Refrigerators and Freezers
It is unsafe to store flammable liquids in a domestic refrigerator or freezer. Even in special refrigerators and freezers, the stored volume must not exceed the amount allowed in a flammable liquid storage cabinet.

Storage Containers
Individual glass containers of Class I-A liquids must not exceed 1 pint (500 ml) capacity. Individual glass containers Class 1-B liquids must not exceed 1 quart (1 liter) capacity. Exception: Class I-A and I-B 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. Class I-A liquids can be stored in metal or plastic containers not larger than 1 gallon (4 liters) capacity, or U.L. listed safety cans not larger than 2 gallons (8 liters) capacity. For liquids other than Class I-A liquids, the capacity of the containers regardless of type (i.e., metal, glass, etc) must not exceed five (5) gallons each.

Chart 1 – Containers
Chart 1 describes the maximum type and size of container you are allowed to store based on the liquid's hazard classification.

<table>
<thead>
<tr>
<th>Container Type</th>
<th>Class I-A</th>
<th>Class I-B</th>
<th>Class I-C</th>
<th>Class II</th>
<th>Class III-A – B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1 pint (0.47L)</td>
<td>1 quart (0.94L)</td>
<td>1 gallon (3.79L)</td>
<td>1 gallon (3.79L)</td>
<td>1 gallon (3.79L)</td>
</tr>
<tr>
<td>Metal or listed, approved plastic</td>
<td>1 gallon (3.79L)</td>
<td>5 gallon (18.95L)</td>
<td>5 gallon (18.95L)</td>
<td>5 gallon (18.95L)</td>
<td>5 gallon (18.95L)</td>
</tr>
<tr>
<td>Approved plastic</td>
<td>0 gallon</td>
<td>0 gallon</td>
<td>0 gallon</td>
<td>0 gallon</td>
<td>5 gallon (18.95L)</td>
</tr>
<tr>
<td>Safety cans</td>
<td>2 gallon (7.58L)</td>
<td>2 gallon (7.58L)</td>
<td>2 gallon (7.58L)</td>
<td>5 gallon (18.95L)</td>
<td>5 gallon (18.95L)</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>0 gallon</td>
<td>0 gallon</td>
<td>0 gallon</td>
<td>60 gallon (227.4L)</td>
<td>60 gallon (227.4L)</td>
</tr>
<tr>
<td>Metal drums</td>
<td></td>
<td></td>
<td>60 gallon (227.4L)</td>
<td>60 gallon (227.4L)</td>
<td>60 gallon (227.4L)</td>
</tr>
</tbody>
</table>

Exceptions may be made to this requirement for storage of Class I-A and I-B liquids with approval from the Department of Safety & Risk Management, (707) 654-1076.
Quantities may not exceed 1 gallon (3.79L).

Chart 2 – Quantity
Chart 2 describes the allowable total quantity of flammable or combustible liquid that may be stored in a Cal Maritime facility.

<table>
<thead>
<tr>
<th>Location</th>
<th>Maximum amount</th>
<th>Container size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open lab or shop (including safety cans)</td>
<td>10 gallons (37.9L)</td>
<td>Comply with Chart 1</td>
</tr>
<tr>
<td>Listed and approved flammable storage cabinet</td>
<td>60 gallons (227.4L)</td>
<td></td>
</tr>
</tbody>
</table>

Combustible liquids
Reasonable quantities of combustible liquids are permitted. For consultation:
Contact the Department of Safety & Risk Management, (707) 654-1076.

Other Resources & References
- Flammable Liquids, Gases and Vapors - Design, Construction, and Capacity of Containers – Code of Regulations (CCR), Title 8, §5532
- Flammable Liquids, Gases and Vapors - Office, Educational and Institutional Occupancies – Code of Regulations (CCR), Title 8, §5538

Refer to Chemical Hygiene Safety Program and Flammable Materials Plan for the complete details located on the Department of Safety & Risk Management webpage.