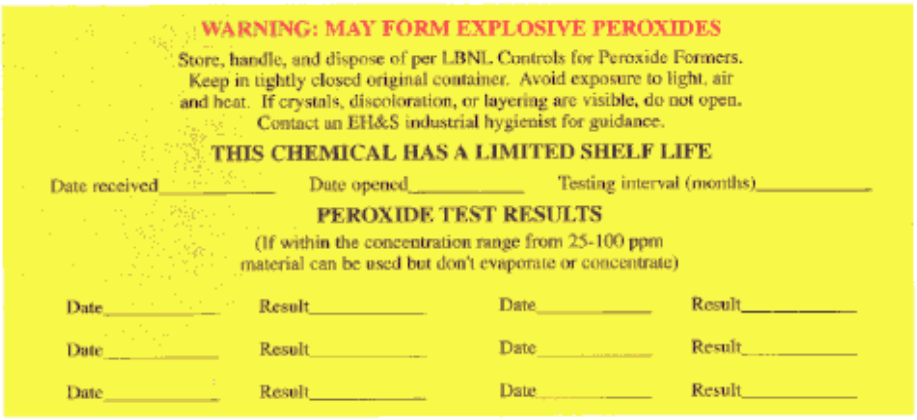
CHEMICAL STORAGE

Proper chemical storage is required to minimize the hazards associated leaks, spills, and accidental mixing of incompatible chemicals.

General Storage Guidelines

Observe the following general storage guidelines. (NOTE: Specific guidelines are presented in the appendix link):

- Use sources such as MSDSs for guidance on storage, incompatibility, reactivity and stability for chemicals.
- Do not tip bottles when returning them to a shelf. Shelves must have enough clearance to accommodate the largest container.
- Do not store chemicals (except cleaners) under sinks. Use approved flammable storage lockers, corrosive storage lockers, shelves or cabinets.
- Avoid stockpiling chemicals.
- Purchase only what is needed. If possible borrow chemicals from a colleague or contact the Chemical Management System coordinator to assist you in finding a source of the chemical at LBNL.
- Conduct periodic cleanouts to prevent accumulating unnecessary chemicals.
- Do not sort and store chemicals alphabetically unless they have first been separated into hazard classes
- Ensure that caps and lids on all chemical containers are tightly closed to prevent evaporation of contents. A Teflon or PVC cap liner may be used to provide a better seal. These are available through several commercial sources, including VWR Scientific. The Laboratory has a “B2B contract” with VWR. These can be ordered online through Procurement’s Web page.
- Avoid exposure of chemicals to heat or direct sunlight. This may lead to the deterioration of storage containers and labels, as well as the degradation of the chemicals. Some time-sensitive chemicals such as peroxide-formers can be affected as well.
- Store solids on shelves or in cabinets.
- Install Plexiglas lips or use equivalent means to prevent materials from falling off storage shelves.
- Avoid storing chemicals on countertops or in fume hoods except for those being currently used.



Segregation and Storage of Chemicals According to Hazard Class

Chemical storage guidelines are presented below. Use these to segregate and store chemicals according to their hazard class. This prevents an undesirable chemical reaction from occurring should two or more chemicals accidently mix. Consult sources such as the substance's Material Safety Data Sheet for specific storage guidelines.

Chemical Incompatibility Matrix

The chemical incompatibilities shown below are not exhaustive. As a result, it is important for Laboratory personnel to research the properties of the chemicals they are using. Use sources such as Material Safety Data Sheets (MSDSs) for guidance on chemical incompatibility. Also ensure you read the container's label – it should also have storage guidelines.

	Acids, inorganic	Acids, oxidizing	Acids, organic	Alkalis (bases)	Oxidizers	Poisons, inorganic	Poisons, organic	Water-reactives	Organic solvents
Acids, inorganic			X	X		X	X	X	X
Acids, oxidizing			X	X		X	X	X	X
Acids, organic	X	X		X	X	X	X	X	
Alkalis (bases)	X	X	X				X	X	X
Oxidizer			X				X	X	X

s									
Poisons, inorganic	**X**	**X**	**X**				**X**	**X**	**X**
Poisons, organic	**X**	**X**	**X**	**X**	**X**	**X**			
Water-reactives	**X**	**X**	**X**	**X**	**X**	**X**			
Organic solvents	**X**	**X**		**X**	**X**	**X**			

X = Not compatible—do not store together

Segregation and Storage With Respect To Hazard Class

Acids

- Segregate acids from reactive metals such as sodium, potassium, and magnesium.
- Segregate oxidizing acids from organic acid and flammable and combustible materials.
- Store acetic acid as a flammable liquid. This is an organic (carboxylic) acid that will react if it comes in contact with an oxidizing acid.
- Nitric acid and hydrochloric acid may be stored in the same corrosive storage cabinet, but they must be kept in separate drip trays. These can combine to form chlorine and nitrosyl chloride gases—both are toxic.
- Segregate acids from chemicals that could generate toxic or flammable gases upon contact, such as sodium cyanide, iron sulfide and calcium carbide.
- Segregate acids from bases.
- See "Control Procedures for Acids and Bases."

Bases

- Segregate bases from acids, metals, explosives, organic peroxides and easily ignitable materials.
- Do not store aqueous sodium and potassium hydroxide solutions in aluminum drip trays. These will corrode aluminum.
- See "Control Procedures for Acids and Bases."

Solvents (Flammable and combustible liquids)

- Store in approved safety cans or cabinets.
- Segregate from oxidizing acids and oxidizers.
- Keep away from any source of ignition: heat, sparks, or open flames.
- See Control Procedures for Flammable and Combustible Liquids.

Oxidizers

- Keep away from combustible and flammable materials.
- Keep away from reducing agents such as zinc, alkali metals, and formic acid.

Cyanides

- Segregate from aqueous solutions, acids and oxidizers.

Water-Reactive Chemicals

- Store in a cool, dry place, away from any water source.
- Make certain that a Class D fire extinguisher is available in case of fire.
- See Control Procedures for Water-Reactive Chemicals.

Pyrophoric Substances

- If in original container store in a cool, dry place, making provisions for an airtight seal.
- Store in a glove box after the material has been opened.

Light-Sensitive Chemicals

- Store in amber bottles in a cool, dry, dark place.

Peroxide-Forming Chemicals

- Most peroxide forming chemicals are also flammable liquids. Therefore, store in airtight containers in a flammable storage locker.
- Segregate from oxidizers and acids.
- See "Control Procedures for Peroxide-Forming Chemicals." for additional information and controls

Toxic Chemicals

- Store according to the nature of the chemical, using appropriate security where necessary.

Chemical Incompatibility Table

The following table is another resource for determining chemical incompatibilities. Like the preceding matrix, this is not exhaustive. Therefore, use sources such as MSDSs to determine chemical incompatibility. The container's label should also provide storage guidelines.

CHEMICAL	KEEP OUT OF CONTACT WITH
Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates and other oxidizers
Acetone	Concentrated nitric and sulfuric acid mixtures, and strong bases
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Alkali metals	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, the halogens
Ammonia, anhydrous	Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenic materials	Any reducing agent
Azides	Acids
Bromine	Same as chlorine
Calcium oxide	Water
Carbon (activated)	Calcium hypochlorite, all oxidizing agents
Carbon tetrachloride	Sodium
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organic or combustible materials
Chromic acid and chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, glycerin, turpentine, alcohol, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids, organic or inorganic
Cyanides	Acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen

	peroxide, nitric acid, sodium peroxide, halogens
Hydrocarbons	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	Nitric acid, alkali
Hydrofluoric acid	Ammonia, aqueous or anhydrous, bases and silica
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, flammable liquids
Hydrogen sulfide	Fuming nitric acid, other acids, oxidizing gases, acetylene, ammonia (aqueous or anhydrous), hydrogen
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Sulfuric acid
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass, any heavy metals
Nitrites	Acids
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Silver, mercury
Oxygen	Oils, grease, hydrogen; flammable liquids, solids, or gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, and oils
Peroxides, organic	Acids (organic or mineral), avoid friction, store cold
Phosphorus (white)	Air, oxygen, alkalis, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate and perchlorate	Sulfuric and other acids
Potassium permanganate	Glycerin, ethylene glycol, benzaldehyde, sulfuric acid
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid

Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric Acid	Potassium chlorate, potassium perchlorate, potassium permanganate (or compounds with similar light metals, such as sodium, lithium, etc.)
Tellurides	Reducing agents

(From Manufacturing Chemists' Association, *Guide for Safety in the Chemical Laboratory*, pp. 215–217, Van Nostrand Reinhold, 2nd Edition.)

Secondary Containment for Liquids: Drip Trays

- Store all hazardous liquid chemicals in drip trays . This is to minimize the impact and spread of a spill resulting from broken/leaking containers Tray capacity must be 110% of the largest container or 10% of the aggregate volume of all containers, whichever is larger.
- Drip trays are available in different materials which provide varying resistance to chemical attack. It is important to use chemical resistance data to select the proper material when using plastic drip trays. This is discussed in more detail below. Avoid using aluminum roasting pans. They do not offer good resistance to corrosive chemicals such as acids and alkali bases. Moreover, disposable roasting pans are flimsy and will develop cracks and tears.

- Photo trays
    - Generally, these provide good resistance for aqueous solutions and some organic solvents. But may not be a good choice for halogenated solvents
    - Photo trays are available through several commercial sources, including VWR Scientific. An additional source of spill containment trays is

Scientific Plastics. This company provides trays in several depths, with width and length in 1" increments. These trays have been used at LBNL to contain entire shelves in storage cabinets.

- Polypropylene and Hi Density Polyethylene Trays
  - These are subject to attack by some aromatic and halogenated hydrocarbons.
  - The Nalgene website has a chemical resistance database for these materials
- Stainless Steel and Pyrex Trays
  - Stainless steel and Pyrex trays are resistant to a broader spectrum of chemicals. However they are more costly than plastic trays and aren't available in as many different sizes and configurations. .

Squeeze Bottles, Wash Bottles and Nalgene Bottles

- Label all containers (e.g., squeeze bottles, wash bottles and Nalgene bottles) to which hazardous materials are transferred with the identity of the substance and its hazards. See the section entitled Training and Hazard Information for additional requirements.
- Be aware that squeeze bottles and Nalgene bottles have varying resistances to different chemicals. (They are usually made from plastics, such as high-density polyethylene, low-density polyethylene and polypropylene). Moreover, they may deteriorate over time, especially when exposed to direct sunlight or UV sources. Consult the Nalgene Web site to determine the chemical resistance of different plastic materials.

Chemical Storage Cabinets

- Use approved corrosive storage cabinets constructed of chemically resistant components for storing acids and bases. Consult Control Procedures for Acids and Bases for additional information.
- Use flammable storage cabinets to store flammable liquids. PUB-3000, Chapter 12, "Fire Prevention and Protection" and the "Control Procedures for Flammable and Combustible Liquids" section contain more information on safe handling and storage of flammable and combustible materials.

Refrigerators

- Refrigerators used for storing chemicals, samples or media must be labeled with words to the effect as follows: “Caution—Do Not Store Food or Beverages in This Refrigerator.”
- Refrigerators and freezers for storing flammable liquids must be designed, constructed, approved, and labeled for that purpose. NOTE: This applies to ethanol and aqueous solutions greater than or equal to 15%). Domestic refrigerator/freezers as well as units that have been modified to remove spark sources are not acceptable alternatives. Refrigerators and freezers are also discussed in “Control Procedures for Flammable and Combustible Liquids.”
- Refrigerators may not be used for food storage in technical areas.
- Labels may be fabricated by users provided they are legible and securely affixed to the refrigerator.