CHEMICALS

Inventory

The Principal Investigator is responsible for maintaining a room by room inventory of all chemicals in the laboratories. This inventory must be regularly updated and should be delivered to **EHS** during each annual safety assessment. Safety information for each chemical may be obtained from the Material Safety Data Sheet (MSDS) for that chemical. **EHS** is the repository for the MSDSs for the University. This information is available to any employee upon request.

Storage

Proper chemical storage is a fundamental aspect of laboratory safety. The number and amounts of chemicals that need to be stored should be kept to a minimum. Chemicals should be stored based on their compatibility and not in alphabetical order. Acids, flammable liquids, halogenated materials, oxidizers, and highly reactive chemicals should all be separated and stored properly to avoid unwanted chemical reactions. Information on chemical storage compatibility can be found in *Table I*.

The following are some general guidelines for chemical storage:

- Storage areas should be well ventilated.
- Chemicals should be stored in cabinets or on shelves. Do not store chemicals on the floor or inside the fume hood.
- Large containers of reagents should be stored on low shelving, preferably in secondary containment in case of leakage.
- Reactive chemicals should be stored in air tight containers away from sources of heat (hot plates, direct sunlight, heaters, etc).
- Flammables requiring refrigeration must be stored in explosion-proof refrigerators.

***Table I* Examples of Incompatible Chemical Storage Groups[1]**

Chemicals listed in Column A are not compatible with those in Column B

COLUMN A	COLUMN B
INORGANIC CHEMICALS	
Hydrides, Hydroxides, Metals, Oxides, Peroxides, Alkali and Alkaline Earth Carbides	Water, Acids, Halogenated Organic Compounds, Halogenating Agents, Oxidizing Agents
Azides	Heavy Metals and their salts, Acids, Oxidizing Agents
Cyanides	Acids, Strong Bases
Nitrates	Acids, Reducing Agents
Nitrites	Acids, Oxidizing Agents
Sulfides	Acids
ORGANIC CHEMICALS	
Organic Compounds	Oxidizing Agents
Organic Acyl Halides and Anhydrides	Bases, Organic Hydroxy and Amino Compounds
Organic Halogen Compounds	Group IA and IIA Metals, Aluminum
Organic Nitro Compounds	Strong Bases
CORROSIVE CHEMICALS	
Oxidizing Agents	Reducing Agents
Chlorates, Chromates, Chromium Trioxide, Dichromates, Halogens, Halogenating Agents, Hydrogen Peroxide, Nitric Acid, Nitrates, Perchlorates, Peroxides, Permanganates, Persulfates	Ammonia (anhydrous and aqueous), Carbon, Metals, Metal Hydrides, Nitrites, Organic Compounds, Phosphorus, Silicon, Sulfur

[1]The information in this table was taken from *Prudent Practices for Handling and Disposal of Chemicals in the Laboratory*. National Academy Press, 1995.

Handling Procedures for Selected Groups of Chemicals

Additional safety procedures should be used when handling the following commonly used groups of chemicals:

Peroxidizable compounds (ethers) are a group of chemicals which become shock sensitive when they form organic peroxides. This reaction is catalyzed by changes in sunlight, temperature, and pressure. Store these compounds airtight and in their original containers, ideally with an inert gas such as nitrogen in the headspace (the area above the liquid in the bottle). Isolate these chemicals from combustible and oxidizable materials, preferably in a flammable storage cabinet. Some examples of peroxidizable compounds can be found in *Table II.*

***Table II* Selected Peroxidizable Compounds[1]**

CLASS I[2]	
Acrylic Acid	Tetrafluoroethylene
Acrylonitrile	Vinyl Acetate
Butadiene	Vinyl Chloride
Chlorobutadiene (Chloroprene)	Vinyl Acetylene
Chlorotrifluoroethylene	Vinyl Pyridine
Methyl Methacrylate	Vinylidene Chloride

CLASS II[3]	
Acetal	Dioxane (p-Dioxane)
Cumene	Ethylene Glycol Dimethyl Ether (Glyme)
Cyclohexene	Furan
Cyclooctene	Methyl Acetylene
Cyclopentene	Methyl Cyclopentane
Diacetylene	Methyl-i-butyl Ketone
Diethylene Glycol Dimethyl Ether (Diglyme)	Tetrahydronaphthalene
Diethyl Ether	Vinyl ethers

CLASS III[4]	
Organic	**Inorganic**
Divinyl Ether	Potassium Metal
Divinyl Acetylene	Potassium Amide
Isopropyl Ether	Sodium Amide (Sodamide)

[1]The information in this table is courtesy of the Emergency Technical Services Corporation of Schaumburg, Illinois.
[2]Unsaturated materials, especially those of low molecular weight, may polymerize violently and hazardously due to peroxide initiation.
[3]These chemicals are a peroxide hazard upon concentration (distillation/evaporation). A test for peroxide should be performed if concentration is intended or suspected.
[4]Peroxides derived from the listed compounds may explode without being concentrated.

Ethers should be purchased in amounts and container sizes appropriate to the intended use and dated upon receipt. Once opened, a container should be used within six months. Even unopened containers should be disposed through **EHS** after one year.

Flammable liquids generate vapors that can readily ignite and burn in air. The rate at which different liquids produce flammable vapors depends on their vapor pressure and temperature. These substances should be stored separately from oxidizers and corrosive materials and in a flammable storage cabinet if available in the work area.

Storage of flammable liquids (including waste) outside approved flammable storage cabinets and safety cans must not exceed 10 gallons per 100 square feet of laboratory space. See *Table III* for storage limitations imposed by OSHA and NFPA.

***Table III* Flammable and Combustible Liquid Storage Limits for Laboratories[1]**

Laboratory Unit Class	Flammable or Combustible Liquid Class	*Excluding* Quantities in Storage Cabinets[2] or Safety Cans: Maximum Quantity[3] per 100 sq ft of Laboratory Unit	*Including* Quantities in Storage Cabinets[2] or Safety Cans: Maximum Quantity[3] per 100 sq ft of Laboratory Unit
A[4]	I	10 gallons	20 gallons
(High Hazard)	I, II, and IIIA	20 gallons	40 gallons
B	I	5 gallons	10 gallons
(Intermediate Hazard)	I, II, and IIIA	10 gallons	20 gallons
C	I	2 gallons	4 gallons
(Low Hazard)	I, II, IIIA	4 gallons	8 gallons

[1]The information in this table was taken from the NFPA 45 standard on *Fire Protection for Laboratories Using Chemicals,* 1996.
[2]Only *Approved Storage Cabinets* as defined by NFPA 45 are allowed by **EHS**.
[3]The maximum quantities of flammable and combustible liquids in Class B and Class C instructional laboratory units shall be 50 percent of those listed.
[4]Class A laboratory units shall not be used as instructional laboratory units.

Corrosive chemicals include strong acids and bases, dehydrating agents, and oxidizing agents. Inhalation of vapors or mists from these substances can cause severe bronchial irritation. These chemicals also erode the skin and respiratory epithelium and are particularly damaging to the eyes. Corrosive chemicals should be stored in corrosion resistant cabinets, and separated from other reagents. Acids should be stored separately from bases and both should be stored separately from flammables and combustibles.

Oxidizing agents, in addition to their corrosive properties, can present fire and explosion hazards on contact with organic compounds or other oxidizable substances. Strong oxidizing agents (see *Table IV*) should be stored and used in glass or other inert containers. Cork and rubber stoppers should not be used with these substances.

***Table IV* Examples of Oxidizing Agents[1]**

Gases:	Fluorine, Chlorine, Ozone, Nitrous Oxide, Steam, Oxygen
Liquids:	Hydrogen Peroxide, Nitric Acid, Perchloric Acid, Bromine, Sulfuric Acid, Water
Solids:	Nitrites, Nitrates, Perchlorates, Peroxides, Chromates, Dichromates, Picrates, Permanganates, Hypochlorites, Bromates, Iodates, Chlorites, Chlorates

[1]The information in this table was taken from *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals.* National Academy Press, 1995.

Highly reactive chemicals are inherently unstable and can react in an uncontrolled manner to liberate heat and toxic gases, which can lead to explosion. These include shock sensitive chemicals, high energy oxidizers, and peroxide formers. Before using these materials, safety information should be reviewed to evaluate proper storage and handling procedures.

The following additional procedures are recommended for handling reactive chemicals:

! Secure reaction equipment properly.

! Use impact protection (shields and guards) in addition to chemical splash protection (eye protection,

gloves, laboratory coat, etc.).

! Handle shock-sensitive chemicals gently to avoid friction, grinding, and impact.

Crossover properties. Many chemicals found in the laboratory exhibit properties common to more than one of the previously mentioned groups (for example, ether). For each chemical, one should simultaneously follow the safety guidelines for all applicable hazard groups. Contact **EHS** for additional information about the storage of a specific chemical.

Extremely Hazardous Chemicals

Certain chemicals have been identified as causing acute and/or chronic health effects. Substances of high acute toxicity cause *immediate* health effects at very low concentrations. Some examples of chemicals with high acute toxicity include the gases hydrogen cyanide, phosgene, and arsine (see *Table V* for additional examples). Substances that have high chronic toxicity may cause adverse health effects after repeated exposure over a period of time. These may include carcinogens, reproductive toxins, mutagens, and sensitizers.

The Principal Investigator (PI) bears the responsibility for the safe use of extremely hazardous chemicals in the laboratory. Researchers must create a *Designated Area* (see definition in the glossary) in the laboratory which is physically separated and visually labeled with appropriate warnings. Access to the Designated Area must be strictly controlled. Engineering controls (such as fume hoods and biosafety cabinets) must also be located in this Area.

***Table V* Examples of Extremely Hazardous Chemicals[1]**

Acrolein	Nickel Carbonyl
Arsine	Nitrogen Dioxide
Chlorine	Osmium Tetroxide
Diazomethane	Ozone
Diborane (gas)	Phosgene
Hydrogen Cyanide	Sodium Azide
Hydrogen Fluoride	Sodium Cyanide
Methyl Fluorosulfonate	Other Cyanide Salts

[1]The information in this table was taken from *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals.* National Academy Press, 1995.

Standard Operating Procedure (SOP)

The PI using extremely hazardous chemicals will be responsible for submitting a Standard Operating Procedure (SOP) to **EHS** for review and approval before this Designated Area can become active. The SOP must outline the methods that will be used, the proper handling of chemicals in the Designated Area and access restrictions to this Area. Researchers can use the general SOP format described in the section of the Manual on Standard Operating Procedures to create this document. Contact **EHS** with additional questions or concerns.

Labeling

All containers (including beakers, vials, flasks, etc.) must be labeled with the chemical constituent(s) and other relevant information. This includes dilute as well as stock solutions. Whenever possible, chemicals should remain

in their original containers with the original labels intact. If a chemical is transferred from its original container, the new container must have the name of the chemical and other relevant information. Damaged or faded labels must be replaced *before* becoming illegible. Additional information on labeling requirements can be found in the Univerity's Right to Know and Hazard Communication Policy.

Waste Disposal

All chemical waste must be disposed according to the policies and procedures for hazardous materials management. See the section on Hazardous (Chemical) Waste Disposal Procedures for more information.

Spills

Each laboratory must maintain a *spill control kit* appropriate for the varieties and quantities of chemicals in that laboratory. This kit must be labeled and accessible. For more information on chemical spill control, see the section on the Management of Spills.