Laboratory Safety Manual

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A) Basic Laboratory Safety Practices

1. Working Alone

Do not work alone in the laboratory if the procedures being conducted are hazardous. If you must work alone, let personnel in other laboratories know of your presence or make someone aware of your location and have them call or check on you periodically.

2. Lab coats and safety glasses

Lab coats and safety glasses are required in laboratories employing chemicals, biohazards, or radioisotopes. Never wear shorts, sandals, or open-toed shoes in lab. Do not wear lab coats, gloves, or other personal protective clothing out of the lab and into non-lab areas. This clothing may have become contaminated and you could spread the contamination.

3. Chemical Exposure

Skin contact with chemicals should be avoided. Do not smell or taste chemicals. Mouth suction must not be used to pipet chemicals or to start a siphon; instead a pipet bulb or an aspirator must be used to provide a vacuum. ***Never pipette anything by mouth.***

4. Washing Hands

Wash hands well with soap and water before leaving the laboratory area. Never wash with organic solvents.

5. Food and Drink

Food and drink increase the change of exposure to chemicals and are prohibited from being prepared or consumed in laboratories using chemicals.

6. Vacuum

Use extra care when evacuating air from glassware. Shield or wrap the glassware to contain chemicals and glass fragments should implosion occur. When possible use thick wall vacuum glassware.

7. Access to Emergency Exits and Equipment

Storage, even temporary storage, and equipment must not block doorways, corridors, aisles, stairways, and laboratory emergency kickout panels to assure unobstructed access to exits in the event of an emergency. Likewise, emergency equipment, such as eyewashes, deluge showers, fire extinguishers, and fire alarm pull stations, must not be blocked and must be quickly accessible.

8. Laboratory Signs

Laboratory signs must be posted as described in Section 4.C. These signs may provide information (e.g., emergency numbers), prohibit unsafe behavior or require protective measures, or designate locations of various supplies and equipment.

9. Other Personal Safety Practices

- Contact lenses should not be worn in a lab because chemicals or particulates can get caught behind them and cause severe damage to the eye.
- Be aware of dangling jewelry, loose clothing, or long hair that might get caught in equipment.
- Store food and drinks in refrigerators that are designated for that use only.

B) Material Safety Data Sheets (MSDSs)

Material Safety Data Sheets (MSDSs) are documents that describe the physical and health hazards of chemicals. Manufacturers of chemicals must provide MSDSs for chemicals that they sell. Although many MSDSs have limited application in laboratories due to their orientation towards industrial use of large quantities of a chemical, they provide basic information that all persons using that chemical need to know. Following addresses are accessing Material Safety Data Sheets on the Web:

-Fisher Scientific

-BDH

-J. T. Baker

-Sigma-Aldrich

Set up your own unique username and password. The first 'search box' is for checking for a chemical by product number. You need to select the brand (Sigma, Aldrich, Fluka, Riedel de-Haen, Supelco or RBI) enter the product (catalog) number, then click the 'Go' button to start the search if a successful search, the MSDS will be displayed (see below to print a copy).

The second search box is for checking for a chemical using "Other Search Options". Select product name, CAS number, molecular formula or full text; enter the search term(s), then click the 'Go' button to start the search; if a successful search, a results page will be displayed; select a product, then select MSDS.

C) Chemical Storage

To avoid dangerous interactions among incompatible chemicals, chemicals should be physically segregated by observing the general classes listed in this section and by checking the MSDS. Incompatible chemicals within these classes should also be segregated.

- General Chemical Storage Guidelines

1) Cabinets - Whenever practical, chemicals should be stored in approved Cabinets

2) Shelves - All shelves should be securely anchored to walls and fitted with 2-inch lipped edges or enclosed in cabinets with latched doors.

3) Heavy Objects - Heavy objects should be stored on lower shelves.

4) Corrosives – Corrosives should be stored only below eye level.

5) Consistent Chemical Storage Locations - Particularly hazardous substances (high acute toxicity chemicals, select carcinogens, mutagens, and teratogens) should be stored together if compatible. Signs should be posted indicating their location and unique hazards.

6) High Degree of Toxicity - Chemicals with a high degree of toxicity (e.g. venoms, mycotoxins, and select agents) should be doubly contained and stored in a locked area accessible only by authorized personnel. Use containers that are chemically resistant and non-breakable.

7) Chemical Waste - Store chemical wastes following the same guidelines as above. Original container labels must be obliterated and the containers must be labeled with a completed INST hazardous waste label.

- Incorrect Storage Practices

1) Acids - Do not store inorganic acids with flammable solvents. Contact of a concentrated oxidizing acid with a flammable solvent may result in a fire or an explosion.

2) Heat/Direct Sunlight - Exposure of chemicals to heat or direct sunlight should be avoided. Even if the chemical is stable, plastic containers have degraded from sunlight.

3) Storage on Floors, on Bench Tops or in Fume Hoods - Chemicals should not be stored on the floor or clutter bench tops. Storing chemicals in a fume hood will compromise the effectiveness of the hood.

4) Storage Height – Do not store heavy containers on the floor or above waist level. Do not store corrosives above eye level. Do not store items closer than 18 inches from the ceiling if the area has fire sprinklers.

5) Hallway Storage – Do not store chemicals in hallways, corridors and exit ways.

D) Chemical Labeling

1-Original Container

The label on an original container must be legible, be written in English and include the chemical name, the hazard warnings and the manufacturer's name and address. If a container label becomes illegible during use, you must affix an extra copy of the original container label or a completed generic label. Chemicals that form peroxides or other hazardous products when exposed to air must be labeled with the date the container was first opened.

2- Transfer to Secondary Container

Chemicals are often transferred from the original container to another container. The secondary container must be labeled with the chemical name (which should be the same name as on the MSDS) and hazard warnings.

3- Labeling Wastes

Waste containers must be labeled. If re-using a container to hold waste, the container must be compatible and appropriate for the waste. Completely deface all old labels.

Transporting Compressed Gas Cylinders

When moving compressed gas cylinders, they must:

1) Have metal outlet cap/plug installed.

2) Have the valve cap installed if the cylinder has one.

3) Be secured in a cart or container designed to prevent the cylinder from falling over while being moved.

Hazard labels for chemicals

Personnel need to take special precautions with chemicals that are reactive, explosive, in compressed gas cylinders, highly toxic, or experimental.

Oxidizing Agent

Flammable

Corrosive

Environmental Hazard

Toxic

Irritant

Explosive Materials

Biohazard

Flammable/Ignitable

A chemical is flammable if it is one of the following:

a) A liquid having a flash point less than 140 °F (e.g., ethanol, xylene, diethyl ether). The flash point is defined as the lowest temperature at which a chemical can form an ignitable mixture with air (by evaporating in the space above an open beaker, for example.) MSDSs include information about flash points.

b) A solid or gas capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a hazard.

c) A solid, liquid, or gas that evolves oxygen either at room temperature or under slight heating (e.g., peroxides, chlorates, perchlorates, nitrates, and permanganates.)

Corrosive

A chemical is corrosive if it is one of the following:

a) An aqueous solution having a pH of less than or equal to 2 or greater than or equal to 12.5.

b) A solid that, when mixed with an equal part of water, will form a solution with a pH as described above.

Reactive

A chemical is reactive if it is one of the following:

a) Normally unstable compound that readily undergoes violent change without detonating (e.g., acrylonitrile, butyl hydroperoxide).

b) When mixed with water, the chemical reacts violently, forms potentially explosive mixtures, or generates toxic gases in sufficient quantities to present a danger to human health (e.g., sodium metal, chloropropionyl chloride).

c) The compound contains cyanides or sulfides that when exposed to pH conditions between 2.0 and 12.5 could generate toxic gases in sufficient

quantities to present a danger to human health (e.g., sodium sulfide, arsenic sulfide).

Toxic

Toxicity is based upon the LC_{50} (concentration of substance required to kill 50% of the tested population) for fish or the LD_{50} (dose amount of substance required to kill 50% of the tested population) for rats. Table. 1 establishes five categories of toxicity: X, A, B, C, and D. The X category (Tox-X) is the most toxic; the smallest dose or lowest concentration is lethal to 50% of the population.

Toxic Category	Fish LC_{50} (ppm)*	Oral (rat) LD_{50} (mg/Kg)	Inhalation (rat) LC_{50}(mg/L)	Dermal (rabbit) LD_{50} (mg/Kg)
X	<0.01	<0.5	<0.02	<2
A	0.01- <0.1	0.5 - <5	0.02 - <0.2	2 - <20
B	0.1- < 1.0	5 - <50	0.2 - <2	20 - <200
C	1.0- <10.0	50 - <500	2 - <20	200 - <2,000
D	10.0 - 100.0	500 - 5,000	20 - 200	2,000 - 20,000

Table. 1 * LC_{50} must be for an exposure period greater than 24 hours

E) Special Chemical Hazards

1) Reactive Chemicals

A chemical is a reactive if it has the capability to undergo violent chemical change, such as explosions or production of toxic fumes, in certain situations. Purchase and use these chemicals in small quantities or find a suitable alternative. Take extreme care when handling and storing these compounds.

a. *Compounds That Generate Toxic Gases (Table. 2)*
b. *Oxidizers (Table. 3)*
c. *Chemicals That May Polymerize (Table. 4)*
d. *Pyrophoric Chemicals : A chemical that will ignite spontaneously in air below 130 °F (54 °C) is apyrophoric. (Table. 5)*
e. *Water Reactive Chemicals (Table. 6)*

Table. 2. **Toxic Gas Generators**

Copper (II) cyanide	Mercury (II) cyanide	Sodium cyanoborohydride
1,4-Dicyanobutane	Methyl sulfide	Sodium dicyanoaurate (I)
Diethyl cyanophosphonate	Octyl cyanide	Sodium sulfide
Fumaryl chloride	Potassium cyanide	Toluene diisocyanate
Heptyl cyanide	Sodium cyanide	

Table. 3. **Oxidizers**

Ammonium dichromate	Lithium perchlorate	Potassium chlorate
Ammonium nitrate	Nitric acid	Potassium permanganate
Chlorine (liquid or gas)	Nitric oxide	Sodium nitrate
Chromic acid	Oxygen (liquid or gas)	Strontium nitrate
Guanidine nitrate	Perchloric acid	Sulfuric acid

Table. 4. **Chemicals that May Polymerize**

Acrylic acid	Isopropenyl acetate	Vinyl bromide
Acrylonitrile	Styrene	2-Vinylpyridine
1,3-Butadiene		

Table. 5. **Pyrophoric Chemicals**

Barium metal	Phosphorus (all forms)	Tantalum powder
Europium (II) sulfide	Potassium metal	Tert-butyllithium
Lithium - tin alloys	Rubidium metal	Triethylphosphine
Lithium diisopropyl amide	Silane	Tri-n-butylphosphine
Methyl lithium	Sodium metal	

Table. 6. **Water Reactive Chemicals**

Alpha-toluenesulfonyl fluoride	Oxalyl chloride	Sodium metal
Antimony trichloride	Phosphorus pentachloride	tert-Butyllithium
Calcium hydride	Phosphorus pentasulfide	Titanium (IV) chloride
Hydrobromic acid	Phosphoryl chloride	Trimethylchlorosilane
Lithium aluminum hydride	Potassium metal	

2) Potentially Explosive Chemicals

An explosive chemical, when subjected to heat, impact, friction, electric or chemical charges, can produce a sudden, quick release of pressure, gas, and heat. When detonated in an uncontrolled or unexpected circumstance, explosives can result in serious bodily harm or extensive property damage. Shock sensitive explosives are known to detonate even when bumped or handled normally. Common potentially explosive chemicals are:

a) Nitrated Compounds

Nitrated organics and inorganics constitute the largest class of compounds that are explosive when dehydrated. Purchase nitrated compounds in small quantities. Do not break the seal on the cap until the chemical is needed. When you purchase a nitrated compound, weigh the container and note the weight on the bottle. Prior to subsequent use, weigh the container again. If the container weighs less, add an appropriate solvent to replace the weight lost. After the reagent is opened and an aliquot is taken, again note the weight of the container. Visually inspect the container for problems prior to each use and wipe down the bottleneck, cap, and threads with a wet cloth before resealing:(Some Example in Table. 8)

Table. 8. Nitrated Compounds

Diphenyl hydrazine	3-Nitrotoluene	Trinitrophenol (Picric acid)
Nitrocellulose	Trinitrobenzene	Trinitrotoluene

b) Organic Peroxide-Forming Solvents

Organic peroxide-forming solvents become shock sensitive when allowed to oxidize and form appreciable quantities of explosive peroxides. Most of these solvents are also flammable. Most peroxide forming solvents are colorless, mobile liquids. Oxidation can occur when the solvent is exposed to atmospheric oxygen. This reaction is catalyzed by light as well as by temperature and pressure changes.

Required Procedures

Purchase peroxide forming solvents in small quantities that contain an inhibitor, such as butylated hydroxytoluene (BHT), which will delay the formation of peroxides until the inhibitor is used up. Label the container with the date received and opened. Do not break the seal on the container until the solvent is needed. Once opened, store solvent in an airtight amber glass bottle or metal container, with an inert gas, such as nitrogen, in the headspace.

The biggest dangers of organic peroxides in these solutions are opening the container and distilling. **Do NOT** open or move the container if you see crystals on or around the container cap.

Table Organic Peroxide Forming Solvents

Severe Hazard	High Hazard	Moderate Hazard
3 months *Once exposed to oxygen, rapidly oxidizes forming explosive peroxides.*	**6 months** *Once exposed to oxygen, oxidizes at a moderate rate forming explosive peroxides.*	**12 months** *Once exposed to oxygen, slowly oxidizes forming explosive peroxides.*
Diisopropyl ether	Acetaldehyde	Ethylene glycol ethers
Divinylacetylene	Cumene	Ethyl vinyl ketone
Potassium amide	Cyclohexene	Oleyl alcohol
Potassium metal	Cyclopentene	Tetrabutylammonium fluoride
Sodium amide	Diethyl ether	
Vinylidene dichloride (1,1-Dichloroethylene)	Di-n-propyl ether	Thorium nitrate hydrate
	p-Dioxane	
	Furan	
	Methyl isobutyl ketone	
	Tetrahydrofuran	
	Vinyl ethers	