Section 2 - Chemical Management

Contents

A. BASIC LABORATORY SAFETY PRACTICES

1. Working Alone

Do not work alone in the laboratory if the procedures being conducted involve highly hazardous substances or processes (such as are described in section G later in this section). If you are working alone with lesser hazard chemicals, Get approval from your PI before operations start. let personnel in other laboratories know of your presence and develop an accountability system with your supervisor and associated lab personnel.

2. Prevent Chemical Exposure

Prevent skin contact with chemicals. For example, use appropriate personal protective equipment (PPE) (goggles, gloves, lab coat, etc. per Lab Safety Manual Section 5.B) but consider it as “the last line of defense” and use other precautions such as using appropriate containment equipment and regularly checking that connections are tight. Clean up spills as soon as possible and minimize clutter to avoid inadvertent spills.

Prevent inhalation of chemicals. For example, use a fume hood whenever handling volatile or aerosolized chemicals, even if they are of relatively low toxicity. Cap chemicals as soon as is convenient. Limit the smelling of chemicals to the minimum amount necessary; only smell a chemical if no other method of identifying a chemical is available and just waft the air at the container opening towards your nose.

Prevent ingestion of chemicals. For example, do not 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.

Prevent injection of chemicals. For example, cap needles as soon as the injection is complete. Use needles with inherent safety devices that prevent inadvertent needle sticks. Dispose of sharps into appropriate waste containers. If operating a high pressure system, never check for a pressure leak using your hands.

3. Washing Hands

Wash hands well with soap and water after removing gloves and before leaving the laboratory area. Never wash with organic solvents. (See Section 5.B Personal Protective Equipment and Appendix G Gloves for more information.)

4. Food and Drink

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

a. Glassware/Utensils

Glassware or utensils that have been used for laboratory operations must never be used to prepare or consume food or beverages.

b. Storage of Food/Beverages

Laboratory refrigerators, ice chests, and cold rooms must not be used for food or beverage storage.

5. 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.

6. Access to Emergency Exits and Equipment

Storage, even temporary storage, and equipment must not block doorways, corridors, aisles, stairways, 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 be directly accessible.

7. 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.

Magnetic or framed signs that can be easily moved may be used to designate a temporary hazard. Warning signs must be removed when the hazard no longer exists, such as a sign indicating the presence of a chemical that is no longer kept in a laboratory.

8. Housekeeping

Laboratory bench tops and other work surfaces must be organized and provide enough space to safely carry out procedures. Aisles and egress routes must be clear to allow for prompt

evacuation in the event of a spill, fire or other emergency. Maintain the following in the laboratory at all times:

- Flammable materials are kept away from ignition sources
- Incompatible materials are separated from each other
- Emergency equipment and supplies (e.g., eyewash, spill kits) are accessible
- Fume hoods are kept uncluttered

Shelves, cabinetry, refrigerators and other storage equipment must be orderly and all chemicals and chemical waste properly labelled. Label information should be visible. Storage on the floor must be limited, temporary in nature, and in accordance with this safety manual.

Surfaces must be promptly cleaned if contaminated with hazardous materials and periodically cleaned as needed. Refuse, recyclables and surplus equipment and materials must be removed regularly.

Pneumatic and gas tubing, power, control and data wiring, must be routed so they are protected from physical damage, do not create a tripping hazard, and are adequately secured to appropriate infrastructure.

B. CHEMICAL INVENTORY AND SDSs

Laboratories must maintain chemical inventories in Microsoft Excel, this is intended for emergency planning efforts and helps laboratories comply with federal, state, and local regulations. Chemical inventories, location contacts, and chemical specific hazard summaries are provided to emergency personnel so they know what chemicals may be involved in an accident and who to contact in the event of an emergency. Laboratories use chemical inventories to keep track of chemicals and to avoid unnecessary purchases.

Laboratory staff are required to maintain their chemical inventories.

1. Access to Chemwatch

For access to SDSs, go to (http://www.csuohio.edu/ehs/chemwatch)

You may also phone OEH&S at 216-687-9306.

2. Conducting your Chemical Inventory

Personnel must inventory all chemicals including CFATS chemicals of Interest (COI), located in the laboratory and specify the maximum amount normally found at this location. Dilutions and reagents prepared in the lab for further work do not need to be added to the inventory, but must have a container label applied unless the preparation will be all used or disposed that day. Review and update inventories annually and whenever there are significant changes in your chemical inventory, a change in COI quantity, or when you are moving a laboratory or starting a new project.

While conducting your inventory, examine containers for deterioration and integrity. Chemicals that are expired, in bad shape or no longer needed must be managed as hazardous chemical waste. For more information about chemical waste management, see Section 3 of this manual.

After completing the inventory, submit your inventory to EHS, print two copies of the inventory: one copy for the lab and one for home in case of an after-hours emergency in the laboratory.

3. Safety Data Sheet (SDS)

Safety Data Sheets (SDSs) are documents that describe the physical and health hazards of chemicals. Manufacturers of chemicals must provide SDSs for chemicals that they sell. Recent changes in the regulation require the manufacturers to begin replacing MSDS with the new SDS format. Although many SDSs 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.

Chemwatch is the centralized SDS database for chemicals used by University personnel (see Section B.1, above).

Laboratory staff and students must have ready access to SDSs for all chemicals used in the laboratory. The department or laboratory may choose whether to maintain the SDSs in either electronic or paper format. The source of the SDS is less important than the requirement that all personnel using chemicals or working around the chemicals must be able to demonstrate that they can retrieve the SDS for a chemical within a short period (such as within five minutes). Chemwatch allows researchers to link to electronic SDSs directly, so is a suitable tool for fulfilling this requirement.

EH&S recommends laboratories maintain paper copies of SDSs for the hazardous chemicals most likely to spill and/or cause injury to someone. Having an SDS immediately available when someone has been exposed to a hazardous chemical helps emergency personnel decide how to respond and treat that person.

Call EH&S at 216-687-9306 to request assistance locating or accessing SDSs during business hours. If the SDS is online in the Chemwatch system, they can be printed out from a local printer. Chemicals that do not have an SDS in the system will take longer to research and obtain.

If an SDS is received with a chemical shipment please maintain a copy in the lab, and send a copy to EH&S (1802 east 25 street, Cleveland Ohio 44115) for addition to the Chemwatch database.

C. CHEMICAL PROCUREMENT

Most chemical products can be purchased without restriction from suppliers through eProcurement (on-line ordering system)(MagnusMart) or through CSU Purchasing Services. However, the following rules and guidelines apply to all chemicals.

1. Hazardous Chemicals

Order only the amount of chemicals needed. Many manufacturers will supply smaller quantities or containers if requested by the purchaser. Do not stockpile chemicals. Chemicals that are expired and/or appear to be no longer useful are considered hazardous waste.

Purchase hazardous chemicals in plastic coated bottles (when available) instead of uncoated glass bottles.

If possible, hazardous chemicals should be received directly by the laboratory. If it is received in an office, there should be a safe location such as a designated table with adequate open space reserved for temporary storage of the package.

When you open a shipment, you should verify that the proper chemical was sent, that the container is intact, and that the label is legible. The date of receipt should be written on the container's label.

2. Pharmaceuticals

Pharmaceuticals, *e.g.* antibiotics, heparin, sterile water, and over the counter drugs, can be purchased through CSU Health and Wellness Services. *Only if you are a patient*. For more information, go to http://www.csuohio.edu/health/health.

3. DEA Controlled Substances

DEA registrants can obtain controlled substances from a drug company, wholesaler or CSU Health and Wellness Services. If you wish to order a controlled substance through CSU Health and Wellness Services, a current Controlled Substances Registration Certificate must be faxed or mailed to CSU Health and Wellness Services before an order can be filled. Controlled substances must be stored in a locked cabinet with limited access. A perpetual inventory must be maintained and the inventory forms used must meet
DEA and State regulations. Expired or waste (undesired) drug must be kept secure in a locked cabinet in a separate container properly labeled for content, and inventoried until disposal. Drug Services or EH&S will provide the contact information of DEA-licensed reverse distributors who must be used for disposal.

4. Non-Denatured Ethyl Alcohol

Instructions for obtaining approval and purchasing non-denatured ethyl alcohol are detailed in the Chemical Procurement Program and list of buildings where it is authorized for use.

5. Radioactive Materials

The Ohio Health Department, Bureau of Radiation Protection, licenses radioactive materials use. Using radioactive materials requires the prior approval of the Radiation Safety Officer (RSO).Call 2016-687-3715 if you need assistance. Orders for radioactive materials must be authorized before the purchase through Magnus Mart.

6. Highly Dangerous Materials

Materials that are extremely hazardous to property, health or the environment (explosives, pyrophoric materials, highly water reactive chemicals, and highly toxic gases, for examples) must not be procured until the necessary permits and administrative, engineering and environmental controls are in place. Hazardous materials must be stored and used in accordance with numerous regulations including, but not limited to, the State Fire Code and local amendments. See Section G: Special Chemical Hazards, below, for examples. Contact EH&S at 216-687-9306 for more information.

7. Compressed Gas Cylinder Procurement

Whenever possible gas cylinders should be purchased through the preferred supplier, Praxair, Air Gas to ensure that the supplier has a cylinder return authorization program. Contact information concerning Praxair is also available on the EH&S web page(create document on webpage).

If a different vendor must be used to provide a specialty gas, the purchaser must get a written return agreement from the distributor or manufacturer prior to purchasing the gas. It is important that the return agreement include a statement requiring the manufacturer to take back both the cylinder and any unused gas. The purchaser should retain this agreement until the manufacturer has accepted the returned cylinder.

D. CHEMICAL STORAGE

1. Segregate Incompatibles

To avoid dangerous interactions among incompatible chemicals, chemicals should be physically segregated using a scheme such as is described on EH&S web page (insert link) . You can contact EH&S at 216-687-9306 for additional information about chemical hazard classes and compatible storage.

Consideration should also be given to using compatible materials for containers, tubing,and reaction vessels. Several compatibility guides are available on the web, such as at http://www.graco.com/content/dam/graco/ipd/literature/misc/chemical-compatibility-guide/Graco_ChemCompGuideEN-B.pdf. (Caution – this link leaves the CSU EH&S web site.)

2. General Chemical Storage Guidelines

Follow good storage practices no matter wherever the chemicals are stored (i.e. cabinets, refrigerators, or shelves). Some general, good practices are described in Table 2-1, Chemical Storage Recommendations, below.

Table 2-1 Chemical Storage Recommendations

Flammables.	Store in approved safety cans or cabinets. Keep away from any source of ignition: heat, sparks, or open flames. Also see section D.3 below.
Light Sensitive Chemicals	Store in amber bottles in a cool, dry, dark place.
Nitrated compounds	Nitrated compounds can be considered explosive; special care and handling may be required. Also see section G.2.a below.
Oxidizers	Store in a cool dry place.
Peroxidizable Chemicals	Store in airtight containers in a dark and cool place. Most peroxidizable compounds are flammable and should be stored in a flammable liquid storage cabinet or room. Label containers with receiving, and opening dates. Periodically test for the presence of peroxides. Discard before exceeding expiration date. Also see section G.2.b below.
Pyrophoric Substances	(Materials that will react with the air to ignite when exposed, e.g., tert-butyl lithium.) Store in a cool dry place, making provisions for an airtight seal. Also see section G.1.d below.
Toxic Chemicals	Store according to the nature of the chemical, using appropriate security where necessary. Also see section G.1.a below.
Water Reactive Chemicals	Store in a cool dry place away from any water source. Have a Class D fire extinguisher available in case of fire. Also see section G.1.e below.

a. Good Storage Practices

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) Secondary Containment - Use secondary containment to prevent incompatible chemicals from mixing and reacting with each other if they must be stored together. This can be done by placing and storing chemical containers inside plastic bins.

   Secondary containment or spill control (such as placing the container on an absorbent pad) is generally required for containers on the floor.

6) Consistent Chemical Storage Locations - Particularly hazardous substances (highly dangerous or toxic chemicals, select carcinogens, mutagens, and teratogens) should be stored together if compatible. Signs should be posted indicating their location and unique hazards.

7) 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.

8) 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 Hazardous Waste Inventory Sheet http://www.csuohio.edu/sites/default/files/hazardous_waste_inventory.pdf, Secondary containment is required if chemical waste is stored near a floor drain or other drain

to sanitary sewer. Avoid mixing incompatible waste materials. Serious laboratory accidents, have occurred when people have mixed incompatible waste materials. For more information about chemical waste, see Section 3 of this manual.

9) Storage in Refrigerators or Freezers - Laboratories must use properly designed refrigerators or freezers if such appliances are used for storing volatile flammables. The refrigerator/freezer must be certified by the manufacturer for flammable materials storage. More expensive, “explosion-proof” appliances are usually not required for the typical laboratory setting. See the EH&S website at for additional information.

   If containers are placed on refrigerator/freezer door shelves, use secondary containers, additional barriers, velcro or other protective measures to keep them from falling out when the door is opened. Accidents may occur from small bottles stored on refrigerator door shelves falling over, slipping under the shelf bar, and breaking on the floor when the door was opened.

b. Incorrect Storage Practices

1) Acids - Do not store inorganic acids with flammable solvents, flammable acids or combustibles (such as cardboard). Contact of a concentrated oxidizing acid with a flammable solvent may result in a fire or an explosion. Incompatible chemical storage practices are described above in section D.1 in more detail.

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 be so numerous as to clutter bench top work areas. Storing more than a few chemicals in a fume hood will compromise the effectiveness of the hood unless they are stored on a shelf a few inches above the work surface of the fume hood (so that air can enter the slot at the back of the work surface).

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.

6) Storage In or Under Sinks – Chemicals (except cleaners) should not be stored under the sink, near the sink or in the sink, to minimize the chance of accidents and improper discharges to the sanitary sewer.

3. Chemical Storage Quantity Limits

a. Control Zones

Chemical quantities in most University buildings are limited by the local fire code,http://library.amlegal.com/nxt/gateway.dll/Ohio/cleveland_oh/partthreelandusecode/partiiielandusecode-buildingcode/titlexiiibuildingcode/chapter3111-ohiobuildingcode?f=templates$fn=default.htm$3.0$vid=amlegal:cleveland_oh. Limits by hazardous material classification apply to a control zone that may include a suite of laboratories, one or more floors in a building, or the entire building. There are also outdoor control areas for storage of hazardous materials. Quantity limits may be increased if fire sprinklers protect the entire control area or, in some cases, if hazardous materials are in approved cabinets. Buildings under newer codes have

reduced limits in control zones above the second floor, and the higher the floor the greater the reduction. Researchers and other building occupants must cooperate with each other to make sure that hazardous material quantities do not exceed code limits. This can be aided by maintaining an accurate chemical inventory. To assure compliance with the CFD, contact EH&S at 216-687-9306.

b. Flammable Liquids in Basements

Flammable liquids are also limited in basement rooms to comply with the International Fire Code. In Cleveland, flammable liquids are prohibited in basement laboratories except for laboratories conforming to NFPA 30. The Local Cleveland rule is online at http://library.amlegal.com/nxt/gateway.dll/Ohio/cleveland_oh/partthreelandusecode/partiiielandusecode-buildingcode/titlexiiibuildingcode/chapter3111-ohiobuildingcode?f=templates$fn=default.htm$3.0$vid=amlegal:cleveland_oh. For assistance in determining local requirements, contact EH&S at 216-687-9306.

c. Additional Requirements

In a laboratory, a maximum of 20 gallons of flammable liquids, in approved containers, may be stored outside of a flammable liquid cabinet. See the following table, Table 2-2, Approved Flammable Liquid Storage Containers, for container types and limits (Reference: NFPA 30, Table 9.4.3). Flammable liquid containers larger than 5 gallons are not permitted in laboratories without specific approval.

Table 2-2 Approved Flammable Liquid Storage Containers

Container Type	Flammable Liquids			Combustible Liquids	
	Class I-A	Class I-B	Class I-C	Class II	Class III
	Flash Point < 73 °F Boiling Point < 100 °F (Ethyl ether)	Flash Point < 73 °F Boiling Point ≥ 100 °F (Hexane)	Flash Point ≥73 °F and < 100 °F (Diesel fuel)	Flash Point ≥ 100 °F and < 140 °F (Mineral spirits)	Flash Point ≥ 140 °F (Kerosene)
Glass	0.5 L (1.05 pt) *	1 L (1.05 qt) *	5 L (1.3 gal)	5 L (1.3 gal)	20 L (5.3 gal)
Metal	5 L (1.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)
Rigid Plastic IBCs (UN 31H or 31H2)	0	0	0	3000 L	3000 L
Composite IBCs w/flexible inner receptable (UN31HZ2)	0	0	0	0	0
Polyethylene UN 1H1	5 L (1.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)	450 L	450 L
Safety Can	10 L (2.6 gal)	20 L (5.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)
* Containers may be up to 5 Liters for reagents of Analytical Purity Grade or High Grade.					

E. CHEMICAL LABELING

1. Original Container

The label on an original container must be legible and be written in English. It must include the chemical/product name as shown on the MSDS/SDS and the manufacturer's name and address. Do not accept materials if the label is illegible or missing required information.

Beginning on June 1, 2015, labels on chemicals/products shipped from the manufacturer must be consistent with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) There are six required elements after those dates:

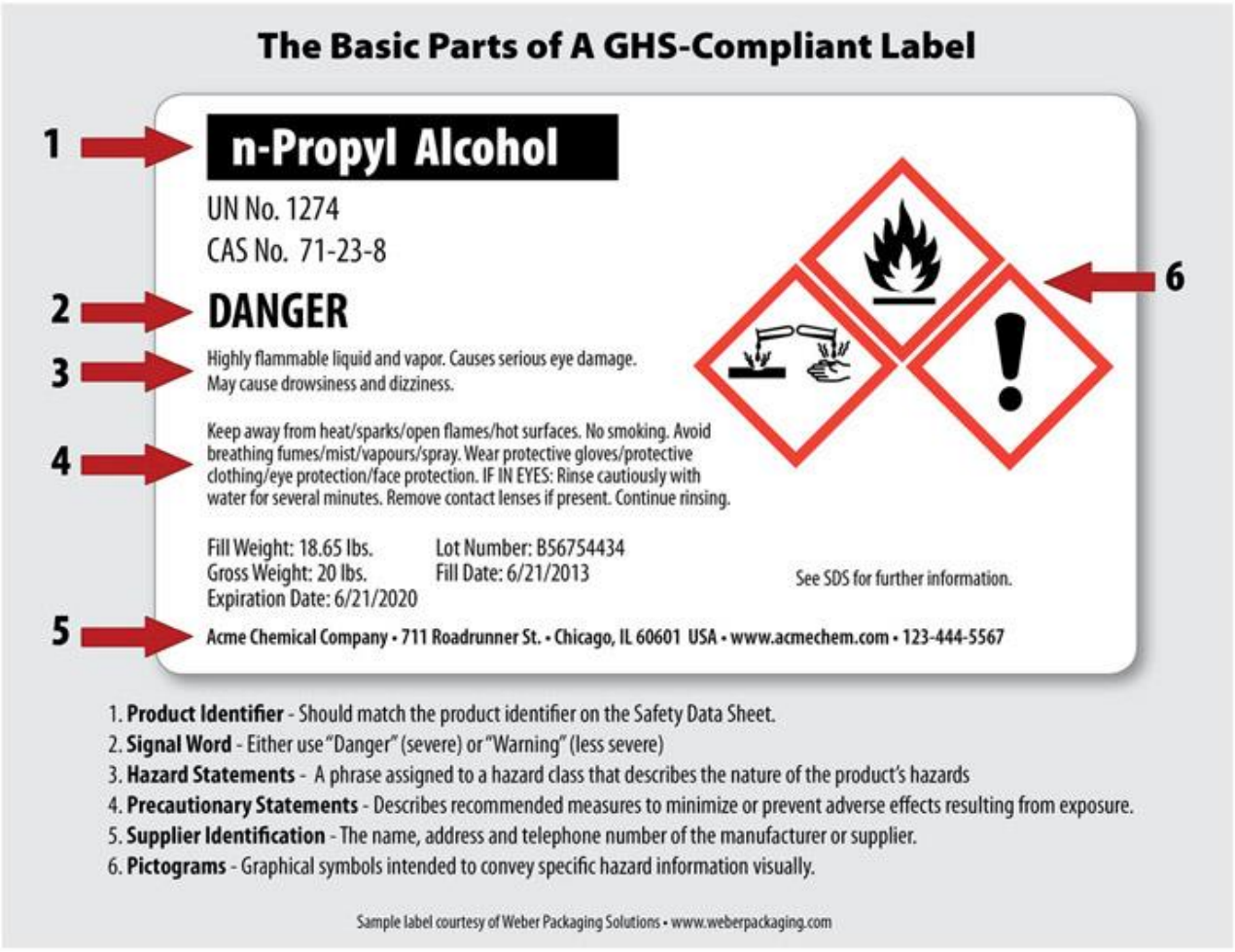
- Product name
- Manufacturer's name and contact information
- Signal word (e.g., danger, warning or no signal word)
- Hazard statement(s) (e.g., toxic if inhaled, combustible liquid)
- Pictogram(s)
- Precautionary Statements (e.g., keep container tightly closed)

An example label is shown below in Figure 2-1, Example of Original Label.

Avoid damaging the original container's label if at all possible. If a container label becomes illegible, replace the label. The replacement label must include the six required elements to be in compliance with GHS rules.

Contact EH&S at 216-687-9306 as needed for assistance in obtaining a replacement label.

Figure 2-1 Example of Original Label



2. Labeling Stock/Working Solutions

Containers of preparations, sample aliquots, and other working solutions are not required to be labeled if the container will be emptied before the end of the work shift and be used by only one person.

If a preparation or working solution will be kept for a longer period or be used by others, the container must be labeled with the following information:

- Identity of the contents. Spell out chemical names
- Signal word, if known or suspected (e.g., danger, warning)
- Hazards, if known or suspected (e.g., flammable, corrosive, irritant)

Information about the signal word and the hazards can be obtained from the MSDS/SDS, but dilutions and reactions may change the hazards and their severity. It is best practice to also label the preparation with the date of preparation and preparer's initials or name.

Your department may require a specific type of label. If so, describe in the laboratory-specific information section of your CHP. The method of affixing the label to the container (i.e., glue, tape or wire) is also at the discretion of the department/laboratory.

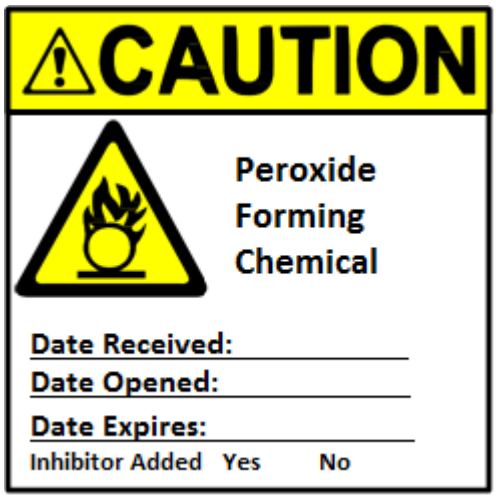
a. Labeling Specialized Containers

Containers that are too small for labels, installed into a process, or would become unusable for their intended purpose if labeled must still have their contents identified in some way. Use any labeling method that enables employees and visitors from other agencies such as the fire department to identify the chemicals and their hazards. Examples include a sign identifying the materials and their hazards, or color or numeric codes cross-referenced on a chart, or room diagrams identifying locations of the chemicals and hazards.

b. Additional Label Required for Peroxide-Forming Chemicals

Label chemicals that form peroxides with the date the container was first opened, using the label shown below.

Figure 2-2 Peroxide Label



General requirements for handling chemicals that form peroxides are described later in this section in paragraph G.2.b.

c. Labeling Waste Containers

Waste containers must be labeled following guidelines in this manual in Section 3 for hazardous chemical waste. If re-using a container to hold waste, the container must be compatible and appropriate for the waste. Completely deface all old labels on containers used for wastes.

F. TRANSPORTING CHEMICALS

Avoid transporting chemical containers which may have contamination on the outside (*i.e.*, avoid the need to wear gloves or other PPE while transporting chemicals). If gloves must be worn, either be escorted by another person to open and close doors and press elevator buttons or remove the glove from one hand and use it to open doors while holding the chemical in the other hand.

1. Transporting between Floors and Buildings on Campus

This section applies to transportation by hand or by cart. In general, when possible, use freight-only elevators when moving chemicals between floors.

a. Moving a Single Chemical

1) The person doing the moving must be trained in the hazards of the chemical and know what to do in the event of a spill of that chemical.

2) The exterior of the container should be clean enough that it could be handled without the need for protective gloves.

3) Chemical bottles must be labeled and should be securely capped and placed in a bottle carrier.

4) Chemical containers that are glass and do not have closing caps or handles should be placed in bottle carriers or larger containers and surrounded by vermiculite or other absorbent material.

5) A lecture bottle should be moved in a manner that protects the valve. Larger gas cylinders must be moved using precautions listed in Section F.1.c below.

b. Moving Multiple Chemicals

1) The person doing the moving must be trained in the hazards of the chemicals and what to do in the event of a spill of those chemicals. The person must also have a spill kit that can handle the spill of those chemicals.

2) The exterior of the containers to be moved should be clean enough that they could be handled without the need for protective gloves.

3) Chemical containers must be labeled and securely closed. Lecture bottles should be packed in a manner that protects the valve.

4) Chemicals should be grouped by compatibility and by hazard class (e.g., flammable, toxic, etc.) and each group should be placed in larger containers or tubs while being transported.

5) Containers used to transport multiple chemicals should be lined with an absorbent material such as vermiculite to cushion the load and absorb and contain any spills. Multiple glass bottles in the same tub should be cushioned using the absorbent to prevent the bottles from rattling against each other.

6) Carts used to move chemicals should be stable under the load and have wheels large enough to negotiate uneven surfaces without tipping or stopping suddenly.

7) For laboratory moves across campus, EH&S can arrange for a contractor to pack and move your chemicals for you, or you can pack and move them yourself using proper DOT packaging protocols. Refer to Section 10.B.2 of this manual for details.

c. Compressed Gas Cylinders

When moving compressed gas cylinders, they must:

1) Have the metal outlet cap/plug installed,

2) Have the valve cap installed if the cylinder has one, and

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

(See subsection G.7 below for more information about compressed gasses.)

2. Transporting Chemicals off Campus

a. Vehicle Use

You cannot transport hazardous chemicals in your personal vehicles Please contact EHS for a contractor to conduct this service for you.. For more information , call216-687-3715 If you are transporting chemicals for a move, please see F.2.d below.

b. Shipment by Others

If you ship hazardous materials by vehicle or air, you are required by law to be trained and certified (see Section F.2.c, following). This includes situations when you use a commercial contractor (FedEx, United Parcel Service, Yellow Freight, *etc*) to transport a hazardous material for you. You are responsible for complying with all applicable transportation regulations, which ensure the safety of your chemicals as well as those who transport them.

c. Training

Training is required for all people who classify, prepare, package, label, document, or offer a hazardous material for transport. Shippers can receive training by taking the EH&S class *Shipping Hazardous Materials*. Class times and registration can be found on our website at http://www.csuohio.edu/ehs/ehs

d. Laboratory Moves

EH&S will arrange to have a contractor package your chemicals and transport them to your new location if off-campus. There are some materials that they cannot transport (temperature restrictive materials, DEA regulated materials, and radioactive, infectious or explosive materials). See Section 10.B.2 for more details. For more information, call 216-687-9306

G. SPECIAL CHEMICAL HAZARDS

Personnel need to take special precautions with chemicals that are reactive, explosive, highly toxic, sensitizing or allergenic, synthesized chemicals, in compressed gas cylinders or at high pressure, present exceptional flammability hazard or have additional specific requirements due to federal regulations. If the degree of hazard is serious enough, the chemical is classified as a particularly hazardous substance. Criteria for particularly hazardous substances are shown on the EH&S web page, and expanded precautions for use include such things as:

- Improving the security and integrity of the chemical storage,
- Reviewing proposed procedures by another PI,
- More intensive training on the chemical's hazards and the equipment to be used when handling the chemical,
- Requiring increased proficiency before any particular individual may perform the procedures be demonstrated and documented,
- Requiring a second lab worker be in the lab in case of emergencies,
- Ensuring all safety measures are included in the SOPs, and,
- Checking that any additional measures for shipping such materials have been addressed.

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. Chemicals which have an NFPA rating of "3" or "4" for Reactivity are also considered to be particularly hazardous substances due to being highly dangerous, and the extra precautions taken as described in the opening paragraph of Section G above need to be documented in your SOPs.

a. Compounds That Generate Toxic Gases

Some compounds that contain sulfide or that have a cyanide (-CN) functional group can generate toxic gases in sufficient quantities to present a danger to human health when combined with other compounds, such as hydrochloric acid. Examples are shown in Table 2-3.

Table 2-3 Toxic Gas Generators examples

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	

b. Oxidizers

Oxidizers are chemicals that initiate or promote combustion of other materials. Oxidizing agents include halogenated inorganics, nitrates, chromates, persulfates and peroxides. S Examples of oxidizers are shown in Table 2-4.

Table 2-4 Examples of some Oxidizers examples

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

c. Chemicals That May Polymerize

Polymerization is a chemical reaction in which small molecules combine to form larger molecules. Polymerization can be hazardous when the reaction releases large amounts of energy or drastically increases the volume of the chemical. Examples are shown in Table 2-5.

Table 2-5 Chemicals that May Polymerize examples

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

d. Pyrophoric Chemicals

A chemical that will ignite spontaneously in air at or below 130 °F) is a pyrophoric. The oxidation of the compound by oxygen in the air proceeds so rapidly that ignition occurs spontaneously. Such chemicals would be considered “particularly hazardous substances and the extra precautions taken as described in the opening paragraph of Section G above need to be documented in your SOPs. Examples are shown in Table 2-6.

Table 2-6 Pyrophoric Chemicals examples

Barium metal	Potassium metal	Sodium methylate
Lithium diisopropyl amide	Rubidium metal	Tert-butyllithium
Magnesium powder	Silane	Triethylphosphine
Methyl lithium	Sodium hydrosulfite	Tri-n-butylphosphine
Phosphorus sticks	Sodium methoxide	Trimethylaluminum

e. Water Reactive Chemicals

Water reactive chemicals react violently with water to release a gas that is either flammable or presents a health hazard. Alkali metals, many organometallic compounds, and some hydrides react with water to produce heat and flammable hydrogen gas. Some of these reactions proceed so violently that the chemicals are classified by NFPA as Reactive code 3 or 4 and the extra precautions taken as described in the opening paragraph of Section G above need to be documented in your SOPs. Examples of water-reactive chemicals are shown in Table 2-7.

Table 2-7 Water Reactive Chemicals examples

Alpha-toluenesulfonyl fluoride	Oxalyl chloride	Sodium metal
Antimony trichloride	Phosphorus oxychloride	Tert-butyllithium
Calcium hydride	Phosphorus pentachloride	Titanium (IV) chloride
Hydrobromic acid	Phosphorus pentasulfide	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 at the CSU 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.

Additional factors need to be addressed in your SOPs are described in the opening paragraph of Section G above. Examples of nitrated compounds are shown in Table 2-8.

Table 2-8 Nitrated Compounds examples

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

Picric acid is a nitrated compound usually purchased as a solid wet with 10% water. Extreme heat, blasting cap, or electric charge can detonate picric acid. It becomes highly unstable if allowed to dehydrate. When wet, picric acid is an orange color to yellow depending on concentration, compact crystalline solid with the consistency of lumpy sand. When dry, picric acid is a crystalline solid with visible air pockets below the surface.

Picric acid will readily form explosive metal picrate's. These metal picrate's are extremely shock sensitive and will detonate with the slightest movement or vibration. Do not allow picric acid to contact metal that is readily oxidized or be stored in a container with a metal cap. Lead, iron and copper metals are particularly dangerous, due to metallic picrate formation.

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.

The additional precautions you take to control peroxide-forming hazards (described in the opening paragraph of Section G above and in this section) need to be documented in your SOPs. Below is a list of good laboratory practices. For more information, see the Peroxide Forming Chemicals Management and Assessment Guidelines online at (insert link form webpage)

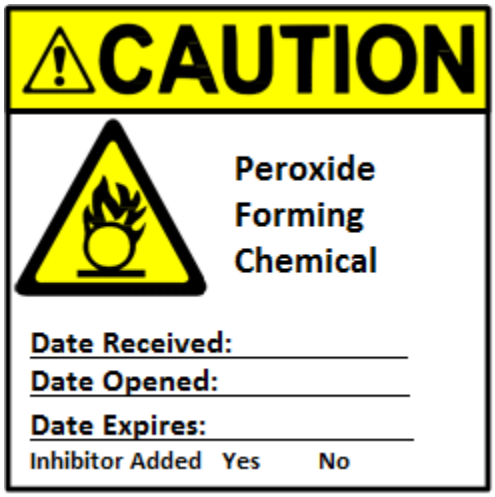
1) Highly Concentrated Peroxides - Over a period of time, peroxide concentrations can increase to hazardous levels. Solvents with high concentrations of peroxides will appear viscous or contain needle-like crystals. If peroxides are visible, no further handling is recommended. Contact EH&S at 216-687-9306 for assistance with professional testing and stabilization.

2) Explosive Capability - Peroxides formed in organic solvents have caused some laboratory accidents, including unexpected explosions during distillation and use.

Such formulations are considered low powered explosives in that they will detonate in moderate concentrations by modest shock, friction, or when heated. 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. Call for assistance if you are concerned about opening the container (EH&S 216-687-9306).

3) 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. Label the container with the standard peroxide label (see Figure 2-4 below). 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.

Figure 2-4 Peroxide Label



4) Testing Peroxides - It is a good laboratory practice to use test strips to test the solvent for peroxides prior to each use. After each use, wipe down the bottleneck, cap and threads with a cloth before resealing. Reduce formed peroxides and add an inhibitor as necessary to keep the concentration of peroxides below 10 ppm. Test and treatment methods can be obtained by calling EH&S 216-687-9306. Extreme caution should be exercised if concentrations of peroxides exceed 30 ppm.

5) Distillation and Evaporation Precautions - Always test for peroxides before distillation or evaporation because these procedures will increase the concentration of any peroxides present. Do not distill or evaporate solvents containing any amount of peroxides. Use a water bath over a hermetically sealed electrical mantle to safely heat the solvent. Use any distilled solvent immediately, or add an inhibitor.

6) Use of Inhibitors – Inhibitors slow the formation of peroxides in the future. They do not reduce or remove peroxides. Organic peroxides should be reduced safely.

7) Monitoring Expiration Date - Use the solvent before the manufacturer’s expiration date. Peroxide-forming solvents exceeding their expiration date cannot be discarded through EH&S until the contents have been tested for peroxides. Examples of peroxide formers are shown in Table 2-9 below.

Table 2-9 Peroxide-Forming Chemicals examples

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 Divinylacetylene Potassium amide Potassium metal Sodium amide Vinylidene dichloride (1,1-Dichloroethylene)	Acetaldehyde Cumene Cyclohexene Cyclopentene Diethyl ether Di-n-propyl ether p-Dioxane Furan Methyl isobutyl ketone Tetrahydrofuran Vinyl ethers	Ethylene glycol ethers Ethyl vinyl ketone Oleyl alcohol Tetrabutylammonium fluoride

c. Azides

Organic and inorganic azides, R-N_3, can explode when heated or exposed to ground glass joints. Some azides are shock sensitive. Metal azides are relatively insensitive to shock, but may explode when heated. Sink disposal of azides can be extremely hazardous because they can form metal azides that are shock sensitive, like iron azide. Azides present a hazard around ground glass joints because they can be shock sensitive. Document additional precautions such as those described in the opening paragraph of Section G above in your SOPs.

d. Fulminates

Fulminates are compounds that contain a carbon-nitrogen-oxygen group. Metal fulminates such as mercury, silver, gold are highly explosive. Explosions are typically initiated by heat. Silver fulminates can form in unopened Tollen's reagent. Document additional precautions such as those described in the opening paragraph of Section G above in your SOPs.

3. Highly Toxic Substances

a. Precautions for Use

In laboratories, "Particularly Hazardous Substances" (described and partially listed in Appendix H) includes those chemicals that are highly toxic. The procedures for using such chemicals require additional precautions, as described above in the opening paragraph in Section G. An important point to be aware of is that a highly toxic gas, like arsine, it is highly recommended not be used until proper engineering controls and fire department notification has been completed. Contact EHS at 216-687-9306 for assistance.

b. Categories of Highly Toxic Chemicals

Various regulatory agencies define highly toxic chemicals differently. Appendix H of this manual provides the CSU criteria for "Highly Toxic" chemicals, which is the same as the definitions used by the Occupational Safety and Health Administration.

The International Fire Code uses essentially the same definition for "highly toxic and poisonous materials" for signage and fire code reasons. Refer to the current IFC, Chapter 37, Highly Toxic and Toxic Materials for additional information about these codes and requirements.

The EPA and Ohio Environmental Protection Agency (OEPA) have other criteria for classifying a chemical as" extremely hazardous" or a "substance with high acute toxicity." These definitions affect their reporting requirements and waste accumulation and disposal requirements.

The Centers for Disease Control and Prevention recognizes "select agents and toxins" which are listed at http://www.cdc.gov/od/sap/docs/salist.pdf. The regulation pertaining to select agents and toxins is available at http://www.cdc.gov/od/sap/index.htm. These materials are allowed in only specific spaces on campus and used by approved individuals. If you intend to use any of these select agents and toxins, pre-approval is required before obtaining them. Please contact EH&S at 216-687-9306 to initiate the approval process.

4. Carcinogens and Reproductive Hazards

Additional care must be taken to minimize exposures to known and suspected carcinogens and reproductive hazard chemicals because inadequate information is available in many cases as to what level of exposure may impact the worker. A partial list of such chemicals is given in Appendix H of this Laboratory Safety Manual, Particularly Hazardous Substances. Ways to minimize exposures include steps such as substituting chemicals if possible, using the smallest amounts necessary, and using a fume hood or other control system. Additional information is available on the EH&S Reproductive Hazards web page at (create webpage/document).

5. Sensitizing or Allergenic Chemicals

Potent chemicals which can cause sensitization or allergy may impact researchers by changing their style of life and in some cases forcing them to leave their areas of research. This hazard is not limited to "traditional" laboratory chemicals in that researchers handling animals can become allergic to animal dander and researchers in forest resources can develop allergies to molds, to give two examples. Additional examples are shown in Table 2-10.

Table 2-10 Sensitizing or Allergenic Chemicals examples

Beryllium	Chromium	Isocyanates
1,2,4-Benzenetricarboxylic anhydride	Diazomethane	Latex
Bichromates	Formaldehyde	Nickel
1,2-Cyclohexanedicarboxylic anhydride	Gluteraldehyde	Phenols (certain types)

Once sensitized, a person may react to extremely low amounts of the chemical. Response may range from a contact dermatitis to anaphylactic shock.

Care must be taken to minimize exposures. Situations which may lead to a high, acute exposure, such as cleaning up a spill, should be carefully assessed to keep the exposure as low as reasonable. If a person is sensitized or allergic to a similar chemical, any control which will prevent exposure to the lab chemical should be implemented, whether improved ventilation, barriers, or improved procedures. If respirators are to be used, the person must comply with all steps in the CSU Respiratory Protection Program http://www.csuohio.edu/sites/default/files/Respiratory%20Protection%20Program%202015_0.pdf).

6. Synthesized Chemicals

Synthesized chemicals may present unexpected hazards. The first step should always be to perform a literature review concerning the expected hazards from the proposed procedures and the hazards from chemicals with similar structure, taking into account that these hazards are being assumed. Pay particular concern to hazards which may develop from reactions or during purification or subsequent activities. Generate minimal quantities until the basic hazards of the chemical can be determined.

a. Nanoparticles

The term “nanoparticle” is given to particles with at least one dimension less than 100 nanometers. They may be deliberately engineered or develop naturally. Such particles may be more reactive and toxic than bulk size chemicals. Take special care to prevent them from being released into the environment. If your laboratory intends to create nanoparticles in such a manner that they may be aerosolized, measurements of the typical nanoparticle levels before the process begins may be taken and compared to subsequent levels. Additional information about nanoparticle safety guidelines is available from the CSU Departmental Chemical Hygiene Officer

b. Providing Synthesized Chemicals to Others

A laboratory synthesizing chemicals for use by others should consider themselves to be a separate entity from Cleveland State University for others receiving the chemical who may need hazard information. Staff synthesizing a hazardous chemical should provide those others with as much information about the safety precautions when using the chemical as is feasible.

7. Compressed Gases and Gas Cylinders

Compressed gas and highly pressurized systems present the unusual hazards that the high pressure may result in a physical hazard from the hose, piping or cylinder flying around if the gas were to escape through a leak, and that the large amounts of gas available may quickly injure personnel due to toxic or asphyxiation hazards from a gas release.

Prior to ordering these gases, contact EH&S at216-687-9306

a. Compressed Gas Shipments

Whenever possible, researchers should purchase compressed gas through the preferred supplier, Praxair. Ordering information is provided on the CSU Magnus Mart web page with details given in section C.7 above.

Inspect the cylinder when it arrives to make sure it is the gas you ordered. Never accept a cylinder with damaged labels, dents, gouges, or burn/heat marks.

b. Safe Practices

The following safe practices should be followed when working with compressed gas cylinders:

1) All cylinders must be clearly labeled by the gas supplier or the user with the cylinder's contents, concentrations, hazard classifications, and safety precautions. Unlabeled cylinders must be disposed of as hazardous waste and users will be charged for an analysis of the contents before its disposal.

2) Secured Cylinders - Cylinders must be secured during storage, transport and use so that they cannot be knocked over. During use, an approved bracket anchored to a fixed structure must be used. It is recommended that the cylinder be secured by two straps or chains located at 1/3 and 2/3 of the cylinder height above the floor.

3) Valve Caps - Cylinder valve caps must be in place when the cylinder is being moved or is not in use for an extended period of time.

4) Moving - Cylinders should be moved with a cart or hand truck designed for strapping on cylinders. Avoid transporting compressed gas cylinders in passenger elevators, use a freight elevator if available.

5) Turning Off - Turn the gas supply off at the cylinder valve first, de- pressurize the system, and then turn off the regulator.

6) When Not Using - If the gas cylinder is not in use, separate oxidizing gases from flammable gases by 20 feet or a one-hour firewall.

7) Use, store, and transport cylinders in an upright position.

8) Highly toxic gases must be stored and used in an approved gas cabinet with fire suppression and release controls or in a certified Chemical Fume hood.

c. Returning or Disposing Cylinders

Whenever possible, gas cylinders should be returned to the supplier as described earlier in this section concerning procurement of gas cylinders (Section 2.C.7). Additional information about cylinder disposal is described in Section 3.P of this Laboratory Safety Manual. If returning full or partially full cylinders, shipping precautions as described on the web page (insert link to webpage or document) need to be followed.

d. Compressed Gas Piping and Tubing

1) Steel, copper or stainless steel must be used for all piping systems serving fixed system and apparatus that are permanently charged or charge while unattended. Qualified personnel must install piping.

2) Piping and tubing must be compatible with the gas.

3) Fuel gas Grade T flexible gas tubing with appropriate hose clamps must be used for all petroleum-based products. This tubing is available through Praxair or other industrial gas supplier.

4) Provide shut off valves, point of use valves, regulators, pressure relief valves, labeling appropriate for the application and in accordance with the International Fire Code and NFPA 45.

e. Regulators

1) Pressure regulators lower the gas pressure to a useable level. There are two kinds of pressure regulator designs: single and two-stage. They appear similar. Single stage regulators are used when precise control of delivery pressure is not required. Two-stage regulators give precise control.

2) Keep regulators clean. Regulators used for oxidant gasses should especially be free of surface oil and grease.

3) Do not use Teflon® tape, putty, or other such materials on the threads unless specifically required (or applied) by the manufacturer/vendor.

4) Always use the proper regulator for the gas in the cylinder. Plaques and decals on the regulator indicate which gas the regulator is designed for.

5) A volume restriction orifice installed downstream of the regulator is required for all toxic and highly toxic gases. Specify pressure and flow requirements when ordering compressed gas so that the vendor provides the proper restriction orifice.

8. Flammable and Combustible Liquids

Read the full SDS for more details before handling flammable and combustible. liquids.

Know the flash points of the flammable or combustible materials that you are using. The flash point is defined as the lowest temperature at which a chemical can vaporize to form an ignitable mixture with air. Many of the common organic solvents and chemicals used in the laboratory have flash points well below room temperature. At or above the flash point temperature, there can be sufficient vapor to ignite if an ignition source is present. Flammable liquids are defined as those having a flash point less than 100 °F (37.8 °C). Combustible liquids have a flash point of 100 °F or higher, but can still produce enough vapor to burn if heated.

Highly flammable chemicals with an NFPA rating of 4 for “Flammability” are also considered particularly hazardous substances and need additional precautions as described in the opening paragraph of Section G above. Also, pre-plan for an emergency by adhering to the precautions in Section 9.A.2.c such as wearing lab coats which resist burning, preventing clutter, and providing clear access to eyewashes, emergency showers and evacuation routes.

The main objectives in working safely with flammable liquids are to avoid accumulation of vapors and to control sources of ignition.

a. Vapor Control

Use less hazardous chemicals if possible. Use the smallest amount of flammable liquid necessary for your procedure. Use closed systems whenever possible. If you must work with open systems, use a fume hood to prevent accumulation of flammable vapor. Close the fume hood sash when not performing your procedure but flammable chemicals are still present.

Each flammable liquid has two fairly definite limits defining the range of concentrations in mixtures with air that will propagate flames or explode. The limits are called the Lower Flammability Limit (LFL) and the Upper Flammability Limit (UFL). These limits are also sometimes referred to as the Lower Explosive Limit (LEL) and the Upper Explosive Limit (UEL). The range that a fire or explosion could occur becomes wider with increasing ambient temperature and in oxygen enriched atmospheres. The flash points and the ranges of LFL to UFL are shown for some typical laboratory chemicals in the following table (Table 2-11. Flash Points and Flammability Limits of Some Chemicals).

Table 2-11 Flash Points and Flammability Limits of Some Chemicals

Chemical	Flash Point °C / °F	Auto-Ignition Temperature °C / °F	Flammability Limits (% volume in air)	
			Lower (LFL)	Upper (UFL)
Acetone	-37.8 / -36	465 / 870	4	60
Benzene	-11.0 / 12	560 / 1040	1.3	7.1
Carbon disulfide	-30.0 / -22	80 / 176	1.3	50
Diethyl ether	-45.0 / -49	160 / 320	1.9	36
Ethanol	12.8 / 55	365 / 690	3.3	19
Methanol	11.1 / 52	385 / 725	6.7	36
Methyl ethyl ketone	-6.1 / 21	516 / 960	1.8	10
Pentane	-40.0 / -40	260 / 500	1.5	7.8
Toluene	4.4 / 40	480 / 896	1.2	7.1

If you are warming flammable liquids above the auto-ignition temperature, make sure there is no exposure to air or oxygen until the temperature drops below the auto-ignition temperature, such as those shown in the table above. Make sure the ovens are appropriately designed for flammable liquids (no internal ignition sources and/or vented mechanically).

If you need to heat flammable liquids, use devices that have good controls, such as steam baths, salt and sand baths, oil baths, heating mantles and hot air baths. Do not use open flames because along with being a potential ignition source, it is also harder to maintain exact control of the heat applied.

You should also minimize the total quantity of flammable materials in the lab, and keep them stored in proper containers (plastic or metal containers or safety cans) as described in Section 2.D.3 above. Cap containers as soon as you have poured out the amount you will need.

To prevent the spill and release of vapors while transporting bottles, use bottle carriers. Dispose of unnecessary flammable chemicals to prevent inadvertent spills.

Be aware that the vapors of many flammable liquids are heavier than air and can travel considerable distances along a benchtop or the floor and can potentially be ignited by an

ignition source located somewhere else in the lab or workspace. These vapors can be generated by a spill or during a simple transfer from one container to another.

b. Ignition Source Control

Control all ignition sources in areas where flammable liquids are used. Open flames and spark-producing equipment should not be used.

Use equipment with spark-free, intrinsically safe induction motors or air motors to avoid producing sparks. These motors must meet National Electric Safety Code Class 1, Division 2, Group C-D explosion resistance specifications. Many stirrers Variacs, outlet strips, ovens, heat tape, hot plates, and heat guns do not conform to these code requirements.

Avoid using equipment with series-wound motors, since they are likely to produce sparks.

Equipment On/Off switches can produce sparks when activated, especially if the equipment uses a lot of power. Place equipment switches as far as possible from any open systems using flammable liquids.

c. Grounding Concerns

Pouring flammable liquids can generate static electricity. The development of static electricity is related to the humidity levels in the area. Cold, dry atmospheres are more likely to facilitate static electricity. Bonding or using grounding straps for metallic or non-metallic containers can prevent static generation.

All metal and polyethylene containers larger than 5 (five) gallons (20 liters) must be grounded to avoid static charge when transferring flammable liquids to another container. Grounding can be direct, as a wire attached to both containers, or indirect, as through wires connected to a common ground system.

When grounding non-metallic containers, contact must be made directly to the liquid rather than to the container.

In the rare circumstance that static electricity cannot be avoided and grounding is not possible, such as pouring small volumes of flammable liquids into a graduate cylinder or beaker, proceed slowly to give any static charge time to disperse. Or, conduct the procedure in an inert atmosphere.

9. Homeland Security Chemicals of Interest

Regulations at Title 6 Code of Federal Regulations Part 27 require all chemical facilities (including universities) comply with the Chemical Facility Anti-Terrorism Standards (CFATS). The rule requires that a chemical facility that either possesses or later comes into possession of listed chemicals (https://www.dhs.gov/sites/default/files/publications/appendix-a-to-part-27-508.pdf) in quantities that meet or exceed threshold quantities report them to the Department of Homeland Security (DHS). Under this regulation, a University building can be deemed a chemical facility and EH&S is charged with reporting building exceedances to DHS. EH&S relies on the accuracy of your chemical inventories maintained in the MyChem Spreadsheet to determine what is reportable.

DHS can require a facility to prepare a security vulnerability assessment and implement a site security plan. Failure to comply with these requirements can result in fines and/or imprisonment.

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10. Process Safety for Highly Hazardous Chemicals

If there is any chance that the quantities of hazardous chemicals handled at one time may exceed the quantity limits of Process Safety Management of Highly Hazardous Chemicals, additional safety precautions must be taken. The basic regulation is viewable at and a table listing chemical limits in pounds that require implementation of this process is in Appendix A to that regulation, https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9761

Among the requirements is a formal, documented failure analysis using techniques such as

- What-If,
- Checklist,
- Fault Tree Analysis,
- Hazard and Operability Study (HAZOP),
- Failure Mode and Effects Analysis (FMEA), or
- Other equivalent methodology for assessing hazards.

Assistance on these techniques is available from EH&S at 216-687-9306. Other requirements, such as storing highly toxic gases in a gas storage cabinet may be required as described in earlier paragraphs in this section.