Chapter 13

LABORATORY CHEMICALS

13.1: General Guidelines for Safe Laboratory Practices

See EHS Laboratory Safety Program at http://www.ehs.psu.edu/labsafety.html

See EHS Laboratory Safety Checklist at: http//www.ehs.psu.edu/labsafety /labcheck.html (Example also found in Appendix F)

See EHS General Safety Inspection Form at: http://www.ehs.psu.edu/ inspect.html (Example also found in Appendix A)

See EHS Laboratory Waste Management Manual at the EHS home page http://www.ehs.psu.edu/

See EHS Waste Management Disposal and Management http://www.ehs.psu.edu/chemwaste.html

The responsibility for personal safety ultimately lies with the individual. It is the responsibility of everyone who works in the College's laboratories to take reasonable measures to protect themselves from injury and laboratory equipment from damage. Here are some guidelines for maintaining safe laboratories.

- Attend all safety training classes required by PSU, your college, or department
- Keep your work area clean, dry, and free of clutter.
- Inspect all equipment prior to use. Do not use damaged equipment.
- Use appropriate personal protective equipment.
- Do not work alone in an area where risk of personal injury is high unless other personnel are aware and can quickly come to your aid if necessary.
- Smoking is forbidden in University laboratories.
- Eating, drinking, and the application of cosmetics should not occur in laboratories.
- If Standard Operating Procedures (SOP) exist for an area, follow them.
- Label all purchased chemicals with the name of the person ordering the chemical and the date the chemical was received.
- Label all mixtures produced with your name, the date prepared, the names and CAS numbers of all constituents, and concentrations of all ingredients in the mixture. Include water and it's concentration as well.
- Upon departure from the University, all chemicals purchased, mixtures prepared, and samples generated by an individual must either be properly disposed of or turned over to their immediate supervisor, the PI, or the department head.

13.1.1 Material Safety Data Sheet

See EHS MSDS Links page at: http://www.ehs.psu.edu/chem/msdsreq.html

See Chapter 11: Material Safety Data Sheets (MSDS)

See Examples of MSDS in Appendix D

Know the rules for general safe handling of all chemicals and equipment you will be using or exposed to in the laboratory. All chemicals have **material safety data sheets (MSDS).** The MSDS contains vital information about flammability, reactivity and health effects from exposure, and other important physical and chemical characterization data. All chemicals are to be shipped with an MSDS. MSDA are also available through the Environmental Health and Safety (EHS) web site.

You should read through the MSDS for all chemicals you will be using in your work. It is recommended that copies of MSDS be kept in a central location in the lab, work group, or department. Hard copy should be filed alphabetically, with all important information (name, CAS number, explosive or volatile conditions, special storage instructions, emergency exposure/containment procedures, etc.) highlighted for quick response. When you bring a new chemical into your laboratory, you are responsible for reading the MSDS, noting exceptional information, and informing others in your lab or area about special health and safety risks associated with that chemical.

13.1.2 Laboratory Fume Hoods

Local exhaust ventilation is the one of the best engineering methods available to reduce the health risk associated with the use of chemicals in the laboratory. Laboratory fume hoods are the most common local exhaust ventilation devices found in the laboratory. Fume hoods are used to prevent hazardous, offensive, or flammable gases and vapors from mixing with the general room air. A hood, especially with the sash down, acts as a physical barrier between the laboratory workers and chemical reactions. The hood can also contain accidental spills of chemicals.

- Do not store chemicals or equipment in a fume hood.
- Do not allow clutter to accumulate under the hood, especially in the back. This can block the exhaust baffles.
- Work to the back of the hood (toward the exhaust vents).
- Be aware of the condition of drains in the hood (i.e. not plugged, filled with clutter, etc.)

Check the MSDS, appropriate Standard Operating Procedure, or chemical label for special ventilation requirements, such as:

- Use with adequate ventilation
- Use in a fume hood
- Avoid inhalation of vapors
- Provide local ventilation

13.1.3 Eye Protection

See PSU Safety Policy SY06, Safety Glasses for Employees

Eye and face protection must be worn to reduce the possibility of injury. It is recommended that eye protection be worn in the laboratory at all times. The need for adequate eye protection is fundamental to the use of chemicals, including housekeeping materials such as wax strippers, detergent and toilet bowl cleaners, as well as operations such as grinding, drilling, sawing with power tools. Eye protection, and at times face protection, is required wherever the potential for eye injury exists. Areas where eye protection must be worn are laboratories, glass cleaning and glassblowing shops, and machine shops or any area where active or automated work with chemicals is conducted. Eye protection shall be made available for all personnel and visitors in these areas.

- Eye protection must be made available to employees, students and visitors, at no cost to them, when the potential for eye injury exists.
- Ordinary (street) prescription glasses do not provide adequate protection. Safety glasses with side shields should be worn where the potential for air born foreign objects exists.
- Safety glasses with side shields do not provide adequate protection from splashes. Therefore, when the potential for a splash hazard exists other eye protection and/or face protection must be worn.
- Splash goggles (acid goggles) with splash proof sides or a face shield must be used when protection from a chemical splash is needed. Face shields afford protection to the face and neck.
- Face shields must be worn if there is an explosion or implosion (pressure or vacuum) hazard and when transferring cryogenic liquids.
- Special eye protection is required for protection against laser, ultraviolet (UV), welding and brazing, or intense light sources.

Remember:

You can eat with False teeth.
You can dance on a wooden leg.
You can’t see through a glass eye.

Managers, supervisors, and principal investigators should understand the types of exposure in their respective areas and see to the provision of adequate eye and/or face protection for these areas. Eye and/or face protection should be easily accessible and clearly available in all appropriate

labs, shops, and work areas. (i.e. hang goggles and face shields outside fume hoods, label drawers containing safety glasses, etc.)

13.1.4 Lab Coats & Shoes

- Lab workers should wear lab coats while in a lab where chemicals are being handled.
- Lab coats should not be worn outside of the lab.
- The employer (principal investigator) must provide lab coats and lab coat laundering services at no cost to all employees who work in the lab.
- Shorts should not be worn under a lab coat.
- Wearing sandals or open toed shoes should be avoided in any laboratory.

13.1.5 Glove Selection

See EHS Glove Selection Chart at: http://www.ehs.psu.edu/labsafety /gloves.html (Chart also found in Appendix F)

Improper glove selection can and has resulted in death. It is imperative that proper glove selection is made. Disposable latex or nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals. These gloves provide a non-chemical resistant barrier between the worker's hand the reagent. Lab workers who contaminate their gloves should immediately removed them, wash their hands and don new gloves. Gloves should not be worn outside of the lab.

Lab workers should contact the principle investigator and MSDS for advice on chemical resistant glove selection when direct or prolonged contact with hazardous chemicals is anticipated. The selection of the proper glove requires knowledge of the health and physical hazards of the chemical that is used, familiarity with the glove manufacturer's test data (permeation rate and breakthrough time) and the length of the hand exposure.

13.2 Storing and Handling of Chemicals

See EHS Chemical Compatibility Chart at: http://www.ehs.psu.edu/compatable.htm

See Chemical Compatibility Chart in Appendix F

See EH&S Chemical Redistribution Program at: http://www.ehs.psu.edu/chem/redist.html

It is the goal of the College to maintain the minimum amount of chemicals needed to conduct normal operations within a laboratory while generating the least amount of waste possible. Carefully read the label and MSDS before storing any chemical. The label or MSDS will provide any

special storage information, cautions, or incompatibilities. Every laboratory should have proper facilities for the storage of chemicals necessary for maintaining its routine operation.

13.2.1 Segregation

NEVER store chemicals in alphabetical order or incompatible chemicals in close proximity to each other. Certain chemicals, when stored or mixed together, may react violently resulting in injuries to personnel and/or damage to equipment. As a rule, chemicals should be stored segregated according to the classes listed below. But even seemingly benign chemicals can react violently under certain circumstances. Before using an unfamiliar chemical for the first time, consult the chemical's MSDS sheet for incompatible chemical combinations. Additionally, lists of incompatible chemicals are available from EHS and on the World Wide Web. **HOWEVER, NO LIST OF INCOMPATIBLE CHEMICALS CAN EVER BE COMPLETE**! Therefore, whenever possible, discuss potential hazards associated with a particular chemical with colleagues or other professionals who have experience with handling the chemical in question.

The following classes of chemicals should be segregated from each other in every laboratory:

Flammable and/or Combustible Liquids and Organic Acids
Flammable Solids
Mineral Acids
Caustics
Oxidizers
Perchloric Acid
Compressed Gases

If you are unaware of the class of chemical(s) you are using, or their proper storage requirements, consult the appropriate MSDS.

Other considerations:

- Use approved storage containers and safety cans for flammable or cryogenic liquids.
- Use spill trays under containers of strong corrosive reagents.
- Do not store liquids above eye level.

The amount of space that can be placed between different chemical classes depends on the amount of storage area available in the lab suite. Do not segregate chemical classes into separate rooms unless they will only be used in that room. Segregation that disrupts normal flow of work or requires more frequent transport of chemicals between labs will increase the probability of a chemical spill. Use common sense in planning chemical storage areas.

13.2.2 Flammable Liquids

See PSU Safety Policy SY08, Storage and Use of Flammable Liquids on University Property

See Chapter 7, Fire Safety

The storage of flammable and combustible liquids in a laboratory, shop, or building area must be kept to the minimum needed for research and operations. When large quantities of flammable liquids are present in a lab they must be stored in a flammable-liquids storage cabinet. Flammable-liquids storage cabinets are not intended for the storage of highly toxic materials, acids, bases, compressed gases or pyrolytic chemicals.

Flammable liquid storage cabinets and their use are governed by the guidelines spelled out in PSU Policy SY08 Storage, Dispensing and Use of Flammable Liquids on University Property. A copy of this guideline is available at the end of this document and on the PSU policies web site.

13.2.3 Cryogenic Liquids

Cryogenic liquids pose several specific hazards, including: thermal burns, frostbite, explosion, increasing flammability conditions, and asphyxiation. This section is intended to address the use of small laboratory cryogenic handling apparatus. When installing units to handle large quantities of cryogenic materials, such a cryogenic production and dispensing stations, contact Environmental Health and Safety and Office of Physical Plant for local regulations and safety standards.

- When handling cryogenic liquids, know the toxicity of the chemical.
- Always handle cryogenics in a well ventilated area. NEVER put your face into dry ice cooling chests or directly over cooling baths.
- Wear protective clothing, which may easily be removed in the event of exposure. Loose fitting, dry, impervious gloves and unlaced shoes are recommended.
- Remove rings, watches and other jewelry which may trap liquids against your skin.
- Glass containers should be solidly taped around the outside.
- Use only loose fitting caps or spring loaded pressure release valves.
- Avoid exposure of cryogenic liquids to atmospheric gases.
- Splash goggles AND splash shields should be worn when filling containers with cryogenic liquids.
- Gloves and tongs should be used to handle materials exposed to cryogenic liquids.

13.2.4 Chemical Stability

See Appendix F for a list of chemicals which can form explosive peroxides.

Stability refers to the susceptibility of the chemical to dangerous decomposition. The label and MSDS will indicate if a chemical is unstable. Example: Ethers and olefins form peroxides on exposure to air and light. Since these chemicals are packaged in an air atmosphere, peroxides can form even though the containers have not been opened. Write the date received and date opened on all containers of ether. Unless an inhibitor was added by the manufacturer, closed containers of ether should be discarded after 1 year. Open containers of ether should be discarded within 6 months of opening. Examples of materials that may form explosive peroxides can be found in Appendix F.

13.2.5 Shock Sensitive Chemicals

See Appendix F for a list of shock sensitive chemicals.

Shock sensitive refers to the susceptibility of the chemical to rapidly decompose or explode when struck, vibrated or otherwise agitated. Some chemicals become increasingly shock sensitive with age. The label and MSDS will indicate if a chemical is shock sensitive.

- Wear appropriate personal protective equipment when handling shock sensitive chemicals.
- Write the date received and date opened on all containers of shock sensitive chemicals.
- Unless an inhibitor was added by the manufacturer, closed containers of shock sensitive materials should be discarded after 1 year.
- Open containers of shock sensitive materials should be discarded within 6 months of opening.
- Some common shock sensitive materials are listed in Appendix F

13.3 General Guidelines for Safe Chemical Usage

NOTE: Any questions concerning the handling of chemicals should be directed to:

Environmental Health and Safety Office
6 Eisenhower Parking Deck
University Park, PA
(814) 865-6391.

Know the hazards associated with the chemicals you are using. Carefully read the chemical's label and Material Safety Data Sheet (MSDS) before using a chemical for the first time. The recommended or required

personal safety equipment for safe use of a chemical (e.g. eye protection, face shield, clothing) should be listed on the chemical's container. If it is not present, consult the chemical's MSDS. Be aware of any special precautions needed to ensure your safety and that of other personnel. Review the appropriate Standard Operating Procedure if one exists. These documents will provide any special handling information that you may need. After the potential hazards associated with the chemicals and the experimental processes are evaluated you can modify work procedures so that laboratory hazards are minimized or eliminated. Keep the following guidelines in mind when handling chemicals:

- Label all containers with chemical content, including CAS numbers and concentrations of mixtures.
- Keep your hands and face clean. Wash thoroughly with soap and water after handling any chemical and whenever you leave the lab.
- Avoid direct contact with any chemical. Always wear a laboratory coat.
- Keep chemicals off your hands, face and clothing, including shoes.
- Never smell, inhale or taste a chemical.
- Use chemicals only as directed and for their intended purpose.
- Wherever possible, substitute hazardous chemicals with less hazardous or non-hazardous chemicals.
- Promptly and properly store all chemicals immediately after use.
- Always use chemicals with adequate ventilation or in a chemical fume hood. Refer to the MSDS and the standard operating procedure to determine what type of ventilation is needed.
- Never use mouth suction to fill a pipette. Use a pipette bulb or other filling device.
- Electrically ground and bond containers using approved methods before transferring or dispensing a flammable liquid from a large container.

13.4 Transporting Chemicals

The transportation of chemicals in laboratory buildings provides the greatest potential for chemical exposure to the building occupants. Spills occurring outside storerooms and laboratories may lead to hazardous concentrations of vapors and gases being distributed throughout the building.

The following guidelines should be observed when transporting chemicals outside the laboratory:

- Chemicals, substances and research materials must be clearly labeled with the correct chemical name when transported. Hand-written labels are acceptable; chemical formulas and structural formulas are not acceptable (except for small quantities of compounds synthesized in the laboratory).
- Carts used for chemical transport must have sides, on each shelf, that are high enough to retain the containers. Cart wheels must be large enough to prevent the carts from being caught in floor cracks, and door and elevator thresholds.

- Personnel transporting chemicals must wear disposable gloves and safety glasses.
- Wherever possible, use the original outside shipping containers (packaging) when transporting chemicals.
- Once opened, chemicals should be placed in a rigid outside container or acid carrying bucket for transporting.
- Incompatible chemicals, for example chromic acid (oxidizing acid) and ethyl acetate (flammable liquid), should not be transported on the same cart unless they are in original shipping cartons and physically separated.
- Flammable liquids should be transported in rugged pressure-resistant safety cans.
- Original containers of flammable liquids shall be placed in an outside container or acid-carrying bucket.
- Original glass shipping containers holding liquid acids and bases must be placed in an outside container or acid-carrying bucket.

13.5 Hazardous Chemicals

See Appendix F for "Guide to Identifying Hazardous Materials"

See Appendix F for "Hazardous Materials Classification Label"

See PSU Policy SY 20 Hazardous Waste Disposal

Hazardous chemical means a chemical for which there is statistically significant evidence that acute or chronic health effects may occur in exposed employees. In most cases, the label will indicate if the chemical is hazardous. Look for key words like caution, hazardous, toxic, dangerous, corrosive, irritant, or carcinogen. Old containers of hazardous chemicals (pre 1985) may not contain hazard warnings. If you are not sure if a chemical you are using is hazardous, review the MSDS or contact your supervisor, instructor, or EHS.

NOTE: Questions concerning the handling of chemicals should be directed to:

Environmental Health and Safety Office
6 Eisenhower Parking Deck
University Park, PA
(814) 865-6391.

13.6 Chemical Spills

In the event of a spill:

- Alert personnel in the area and do what is necessary to protect life
- Notify all personnel in the area if a flammable, carcinogenic, reactive, toxic, or reproductive hazard is spilled.
- Extinguish flames and all other sources of ignition (such as brush-type motors.)

- Maintain fume hood ventilation, vacate the area and call for assistance.
- Confine the spill if possible.
- Call for assistance if the spill is large; a threat to personnel, students or the public; involves radioactive materials, corrosives, highly toxic, or reactive chemicals.

For specific spill cleanup information, contact your supervisor, instructor, or EHS. The Environmental Health and Safety Department (EHS) is equipped to handle many spills that may occur at the University. If there is the slightest doubt how to proceed, do not hesitate to call **(5-6391)** for assistance.

13.6.1 Spill Cleanup Supplies

Anticipate spills by having the appropriate safety equipment on hand. Spill of chemicals that do not pose a fire, toxic, or corrosive hazard, may be cleaned up by the laboratory worker. Use an absorbent material that will neutralize the spill if available. A dustpan and brush should be used and rubber gloves and goggles should be worn during the cleanup. Decontaminate area with soap and water after cleanup. Triple bag residue inside 6ml plastic bag, tag with contents, and place in a container for chemical waste collection. Contact your supervisor, instructor or EHS for disposal information.

Examples of spill cleanup materials include:

- trisodium phosphate
- sodium bicarbonate for acids
- powdered citric acid for bases
- “Oil-Dri,” “Zorb-All,” & “Speedi-Dri”
- paper towels

13.6.2 Hazardous Spills

See Appendix F for “Guide to Identifying Hazardous Materials”

If you spill a hazardous material, isolate the area from other personnel and immediately contact emergency response personnel. Dial 911, 3-1111, or EHS at 5-6391.

The following compounds are very hazardous. You should not clean them up yourself.

aromatic amines	nitro compounds	bromine
ethers	carbon disulfide	hydrazine
cyanides	nitriles	organic halides

- **Elemental mercury** spills should be handled by EHS. This includes broken mercury thermometers.
- Smother **alkali metal** spills with powdered graphite.

· **White Phosphorus** should be smothered with wet sand or wet absorbent.

13.7 Storing Samples

See Compatibility Charts in Appendix F

All samples generated must be properly stored when not being analyzed. The chemical class in which a sample falls is determined by the highest percentage of a hazardous component contained in the sample and its matrix and must be segregated following the procedures listed above. Properly dispose of the unused portion of a sample as soon as possible after analysis. All sample containers must have complete information concerning the sample and its matrix, including relative amounts of each component, printed indelibly on the container.

Sample storage facilities may be limited in some laboratories. Therefore, the person responsible for the laboratory may assign, of necessity, limited space for sample storage within a laboratory. It is the responsibility of the sample generator to arrange, with the help of an advisor or supervisor (if needed), to find alternate facilities for short-term sample storage.

Some samples may need to be retained for extended periods of time. If long term storage is needed and not available in the laboratory, the sample generator, with the help of an advisor or supervisor (if needed) will need to find alternate facilities for long term storage of the samples.

Upon departure from the University, all chemicals purchased and samples generated by an individual must either be properly disposed of or turned over to their immediate supervisor, the PI, or the department head.