PENN STATE

Laboratory Safety Manual

Department of Materials Science & Engineering

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Emergency Phone Numbers

FIRE & ACCIDENT	**911**
POLICE SERVICES	3-1111
HAZARDOUS MATERIAL RELEASE (Chemical Spills)	5-6391
Environmental Health and Safety	5-6391
Physical Plant Service Desk	5-4731

EMS College Safety Manual:
http://www.ems.psu.edu/safetymanual/

Environmental Health and Safety Website:
http://www.ehs.psu.edu/

PREFACE

Most laboratory safety practice is common sense, however, when laboratory operations proceed smoothly without accidents we may become complacent and the perceived need for safeguards becomes increasingly remote. The lack of any serious injury may be a result of either good safety or just plain luck. The value of practicing good safety can be most evident when safety is not practiced.

This, as well as numerous observations in the laboratories, is the underlying motivation for putting together this manual. It is often automatically assumed that everyone is born with good common sense and therefore should practice good safety. The problem is that one cannot ask the right questions if one is not aware of the potential hazards. Laboratory accidents do not always result from ignorance of dangers but rather a diminished awareness of dangers within a familiar environment.

This manual is not an exhaustive treatment of the subject of laboratory safety. It is intended to sensitize the reader to some of the more common hazards that exist in the lab. As each person's concerns may be specific to their project, this guide hopes to point the reader in the right direction to obtain an answer to their specific questions. There are many excellent sources of information and contacts right on-campus, unfortunately they are often not utilized because people are not aware of them.

In order to keep this manual up to date and in accordance with the latest findings in safety procedures, all suggestions to improve this manual are welcome and should be directed to the department safety officer.

As a final note, remember that safe laboratory practice is to our own benefit as well as our colleagues working in the labs with us. A first step to setting up any experiment should be to take a few minutes to think through the potential hazards before proceeding. These may involve chemical, electrical or mechanical dangers. By taking a few minutes to think and ask the right questions we may prevent an unfortunate accident from happening to us, or setting a "booby trap" for our friends.

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I. INTRODUCTION

Safety in the laboratory requires the same kind of continuing attention and effort that is given to research and teaching. The use of new and/or different techniques, chemicals, and equipment requires careful preparation. Reading, instruction, and supervision may be required, possibly in consultation with other people who have special knowledge or experience. Each individual who works in a laboratory has a responsibility to learn the health and safety hazards associated with the materials to be used or produced, and with the equipment to be employed.

It is important for you to know what is expected of you and what your responsibilities are with regard to safety to yourself, your colleagues and our environment. In addition, there are safety practices and safety equipment with which you must be thoroughly familiar if you are to work safely in the laboratory. This manual should be used as a guide to the general types of hazards and a reference source for more specific information pertinent to each individual project.

II. AREAS OF RESPONSIBILITY

A. The principal investigator (P.I.) or laboratory supervisor has the primary responsibility for controlling hazards in his/her laboratory. This shall include: instructing laboratory personal on potential hazards, training students and employees in safe practices, correcting work errors and dangerous conditions, encouraging a positive attitude towards safety, investigating the circumstances surrounding each accident, and taking steps to avoid recurrence. Each student is required to pass a Departmental safety exam before being allowed to work in a laboratory.

B. The laboratory worker shall be responsible for complying with oral and safety rules, regulations, and procedures required for the assigned work.

C. The Environmental Health and Safety Office (865-6391) shall be responsible for assisting individuals and providing technical advice. They shall assist investigators in determining and following safe practices, coordinate safety activities, and provide education in safety. They shall have enforcement authority in dealing with unsafe practices.

III. FIVE PRINCIPLES OF SAFETY

Our Safety Program incorporates only a few principles, but each one is essential. These principles are: A) practice safety, B) be concerned about the safety of others, C) understand the hazards associated with your particular experiment, D) know what to do in an emergency, and E) report hazards or hazardous conditions.

A. Practice Safety

In order to have an effective safety program, some common ground rules must be established. Several basic safety practices that you must follow are:

1. Wear appropriate eye protection whenever working with any potential eye hazards (safety glasses, chemical goggles and face shields).
2. Use a hood for hazardous, volatile, and noxious chemicals.

3. Label an experiment to show its associated dangers and the persons to contact in case of a problem. There must be an up-to-date card posted visibly outside each room listing the responsible persons to call in the event of problems in the room.
4. You are required to secure all gas cylinders, to label all containers, to observe posted signs, such as no smoking, and so on.
5. While the University provides safety equipment in the hallways of buildings, it is the individual's responsibility to provide safety equipment in the laboratories.

The above list of basic safety practices is not exhaustive. Each laboratory procedure and situation requires its own safety practices, which you are expected to know or find out before doing an experiment.

B. Be Concerned About The Safety of Others

Your concern for safety must include the people around you. Your experiment must be safely maintained so that everyone in the area is amply protected and warned of inherent dangers. In addition, this principle of looking out for the other person should include the practice of pointing out unsafe procedures to those people committing the unsafe act. This practice could involve something as simple as reminding a friend to wear safety glasses. Another aspect of this second principle involves alerting those around you of an accident. It is your responsibility to alert personnel in the immediate vicinity of a fire or an emergency!

C. Understand the Hazards Associated with Your Particular Experiment

Prevention is the key to safety. Prior to designing any experiment, using a new piece of equipment, or handling chemicals in the laboratory, it is wise to consider the potential hazards and safety precautions involved in the work. Hazards may include toxic substances, electrical circuits, mechanical equipment, and waste chemicals. Safety precautions should include correct materials storage, proper ventilation, proper grounding of equipment, and training sessions when necessary. Whenever possible, information about the unique hazards and precautions necessary for any type of work should be prepared and made available to everyone working in the lab. Material Safety Data Sheets (MSDS) and equipment manuals are important sources of information. Prior to starting any experiments, an MSDS, which includes toxicological information and special handling requirements must be obtained and read for each chemical to be used. The Environmental Health and Safety Office (EH&S) maintains a file of thousands of MSDS and is available to assist in obtaining them (5-6391). EH&S personnel are also available to review the project safety requirements and potential hazards with you. An example of a MSDS for acetone, and one for alumina powder are included in Appendix B.

D. Know What to do in an Emergency

You must be prepared to respond quickly and precisely to an emergency. You must familiarize yourself with the laboratory you are working in, its exits, and its associated safety equipment: eyewash stations, showers, sinks, fire blankets, fire extinguishers, and spill kits. Appendix A of this manual contains a floor plan which pinpoints the location of each of these in Steidle Building. Just a few moments spent learning the locations and use of these pieces of equipment prior to an emergency could save a life.

If the emergency is of an infiltrating nature, such as a fire, gas leak, release of toxic fumes, or radiation leak, the following procedures should be followed:

- **Alert personnel in the immediate vicinity.**
- **Confine the fire or emergency, if possible.**
- **Summon aid (Dial 911).**
- **Evacuate the building.**
- **Report pertinent information to responding emergency personnel.**

It is worth commenting on each of these procedures.

Alert personnel in the immediate vicinity. When alerting personnel in the vicinity of a fire or emergency, assign several of them the responsibility of assisting in the remaining procedures. Especially assign someone the task of summoning aid!

Confine the fire or emergency, if possible. Confining fires or other emergencies means taking measures to prevent them from spreading. In case of fire, close doors and windows securely. If the fire is not threatening you, use an appropriate fire extinguisher. Do not waste valuable time trying to confine an emergency when it is beyond your control. Follow evacuation procedures.

Evacuate the building. Evacuating the building means sounding the fire alarm system and going to the nearest exit without delay. The elevator should never be used during a fire!

***Summon aid (Dial 911)*.** The Fire Department, the Police Department, and Medical Services can be contacted by dialing 911. When summoning aid, phone from a safe location. You should be prepared to state precisely the location and nature of the emergency. Do not hang up until you have given all of the pertinent information and you are instructed to do so by the dispatcher. University medical response time is around 3 minutes to anywhere on campus.

Report pertinent information to responding emergency personnel. For each student laboratory the instructor will assign one student each week to call 911 if the need arises. Meet, or designate someone to meet, responding emergency personnel at a specific location and report pertinent information such as: personnel trapped, specific location of incident, hazardous materials or equipment involved.

If the emergency does not necessitate a confinement or evacuation procedure, such as an individual being injured, you must still be prepared to alert nearby personnel and summon aid. You may also have to administer some emergency treatment yourself. This emergency treatment could involve the use of safety equipment mentioned previously.

E. Report Hazards or Hazardous Conditions

You must report any incidents without delay. A statement of the problem must be made to Environmental Health and Safety office by dialing 865- 6391 from any campus phone. The building safety officer and your supervisor/advisor should also be notified.

The remainder of this Safety Manual presents examples of hazards that you are likely to encounter in the laboratory and what you should know about them to minimize their danger to you and to others.

IV. EMERGENCIES AND FIRST AID

A. Emergencies

1. In a medical emergency, summon professional medical attention immediately by dialing 911 from any university phone.
2. Be prepared to describe accurately the nature of the accident, the telephone number you are calling from, your name, and describe the existing hazards.
3. Provide first aid within the scope of your training while waiting for professional help to arrive. It is important you do not attempt any medical treatments with which you are unfamiliar.
4. Report all injuries to your supervisor/advisor.
5. Location you are calling from, your name and telephone #.
6. Type of Accident
7. Number of Injured People
8. Existing hazards such as: fire, chemical fumes, leaking gas cylinder, exposed electrical wires.

Use of Emergency Equipment. Everyone working in PSU labs must know how to use emergency equipment such as fire extinguishers, spill kits, safety showers, and eye wash apparatus. Special training on the proper use of all types of emergency equipment is available by calling the Environmental Health and Safety office. Know where these items are located in your laboratories. Appendix A contains a floor plan of Steidle Building which pinpoints the location of safety equipment.

B. First Aid

1. First Aid Kit

A first aid kit shall be located in a clearly visible place in each laboratory. This kit should include contents listed but is not limited to the following:

CONTENTS PER KIT

1 pk	Merthiolate Swabs
1 pk	Wound Cleansing Scrubbers
1 pk	Scissors and Forceps
3 ea	Ammonia Inhalants
1 rl	Dermicel First Aid Tape
5 ea	4” x 4” Gauze Pads
10 ea	2” x 2” Gauze Pads
1 ea	Triangular Bandage
4 ea	5” x 9” Surgipad Combine Dressing
10 ea	Band-Aids
4 prs	Latex or Plastic Gloves
2 ea	Compression Bandages
2 ea	2” x 6 yds. Gauze Rolls

2. Safety Showers and Eyewashes

A safety shower and an eyewash fountain must be located within twenty-five feet of the laboratory work area. Every laboratory worker should know the location of, and how to use the safety shower in order to be able to locate it with eyes closed, if necessary.

C. Injuries Requiring Immediate Treatment

There are certain serious injuries in which time is so important that treatment must be started immediately.

1. Stoppage of Breathing

For stoppage of breathing (e.g. from electrical shock or asphyxiation), the mouth-to-mouth method of resuscitation is far superior to any other known. If victim is found unconscious on the floor and not breathing, rescue breathing must be started at once, seconds count. Do not waste time looking around for help, yell for help while resuscitating victim.

Training in the techniques of mouth-to-mouth resuscitation and Cardio-Pulmonary Resuscitation (CPR) is available through the Emergency Medical Services Office in Ritenour Health Center.

2. Severe Bleeding

Severe bleeding can almost always be controlled by firm and direct pressure on the wound with a pad or cloth. The cleaner the cloth, the more desirable; however, in an emergency, use part of the clothing. The person applying the compress should wear latex or plastic gloves to prevent blood borne contaminants. In addition:

a. Wrap the injured to avoid shock, and call immediately for medical attention.
b. Raise the bleeding part higher than the rest of the body and continue to apply directpressure.
c. Keep victim lying down.
d. Never use a tourniquet.

3. Thermal Burns

a If the burn is minor, apply ice or cold water.
b. In case of a clothing fire:
   i. The victim should drop to the floor and roll, not run to a safety shower. A fire blanket, if nearby, should be used to smother the flames.
   ii. After flames are extinguished, deluge the injured under a safety shower, removing any clothing contaminated with chemicals.
   iii. Keep the water running on the burn for several minutes to remove heat and wash area.
   iv. Place clean, soaking wet, ice-packed cloths on burned areas, and wrap to avoid shock and exposure.
   v. Never use a fire extinguisher on a person with burning clothing.

4. Chemical Burns

a. For chemical burns or splashes, immediately flush with water.
b. Apply a stream of water while removing any clothing that may have been saturated with the chemical.
c. If the splash is in the eye, flush it gently for at least fifteen minutes with clear water. Wash in a direction away from the other eye. Have aid summoned immediately!
d. If the splash is on the body, flood it with plenty of running water for at least 15 minutes. If the exposure is over a small area, have someone drive you to Ritenour Health Center for proper medical attention following the first aid treatment. For large scale exposure have someone call the university ambulance (phone 911).
e. A safety shower, hose, or faucet should be used in an emergency.
f. For chemicals spilled over a large area, quickly remove contaminated clothing while using the safety shower; treat as directed under the section thermal burns. Seconds count, therefore, no time should be wasted simply for modesty.
g. If safety goggles are worn during a chemical exposure to the face, leave them on until the surrounding area is thoroughly rinsed, they may be the only thing keeping the chemical out of your eyes.

5. Traumatic Shock

In cases of traumatic shock, or where the nature of the injury is not clear, keep the victim warm, lying down and quiet. Wait until medical assistance arrives before moving the victim. One should treat all injuries as potential shock situations, as they may turn into one. Some common symptoms of shock are cold and clammy skin, paleness, and deleria.

V. GENERAL LABORATORY SAFETY RULES

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

A. Signs and Labels

1. Emergency Telephone Numbers

A sticker, available from EH&S (865-6391), shall be affixed to the outside of every laboratory and chemical storage area. This sticker should list the names and phone numbers of those individuals to be contacted in the event of an emergency.

A list of telephone numbers for emergency services shall be posted near each phone.

2. Hazard Warning Signs

Clearly visible signs should be posted indicating the nature of any hazard (e.g., biohazards, carcinogens, flammable solvents, radioactive materials, lasers) contained in the laboratory or storage area.

3. Emergency Equipment

Emergency equipment as well as chemicals and waste containers shall be labeled.

B. Handling of Chemicals

1. Personal Precautions

Working alone is not good laboratory practice. An individual will work only under conditions in which appropriate emergency aid is available when needed. In other words, work only when others are around to provide help if it is needed. If others are working nearby, let them know where you will be working so that they can occasionally check on you and you can check on them. Experiments which are hazardous shall not be performed by a worker who is alone in a laboratory. Room lights should be left on and an appropriate warning sign should be placed on the door.

Eye Protection. In all laboratories where chemicals are used there is the hazard of splashes or dust particles entering the eyes. Pressurized or vacuum vessels may explode or implode sending shrapnel through the lab. While working with electrical wiring there are hazards from molten solder and debris. When making mechanical properties tests, pieces can chip and enter the eye. All of these activities, and many others require the use of either safety glasses, chemical goggles or face shields. Most lab operations simply require the use of safety glasses, however, when any chemicals are being used at least chemical goggles should be used or in some cases a face shield is required. The appropriate eye protection is generally specified on the MSDS.

Ear Protection. The healthy ear can detect sounds ranging from 15 to 20,000 hertz. Temporary exposure to high noise levels will produce a temporary hearing loss. Long term exposure to high noise levels produces permanent hearing loss. There appears to be no hearing hazard (although possible psychological effects) to noise exposure below 80 dB. Exposure above 130 dB is hazardous and should be avoided. Ear muffs offer the highest noise attenuation, and are preferred for levels above 95 dB. Ear plugs are more comfortable and are preferred in the 80-95 dB range. If you suspect that a hearing hazard exists then notify Environmental Health and Safety to have the sound level measured.

Respiratory Protection. Use only respirators provided and/or recommended by EH & S. There are many shapes and sizes of respirators and in order to be effective it must be properly fitted. There are also a variety of cartridges available each having a specific application. The cloth respirators available in the stockrooms provide only minimal dust protection and no chemical protection. They should never be used with any toxic material. Respirators should only be used following proper fitting and instruction by EH&S personnel.

Clothing. In situations where splashing or spills may occur it is wise to protect your body with lab coats, goggles and face shields, splash aprons, and gloves may be needed for chemicals that are corrosive or easily absorb through the skin. Shorts and open-toed shoes are not recommended when working in the lab. Do not work in a laboratory wearing loose hair, loose clothing or dangling jewelry. Any questions regarding appropriate protective equipment can be directed to EH&S.

Hand Protection. For any laboratory procedure requiring the use of gloves, make sure you are using gloves made of a material suitable for the operation. Gloves are made of a variety of materials and have specific uses, if used improperly they may not provide

the necessary protection. The MSDS should specify the glove type but if in doubt call EH&S for assistance.

Footwear. Shoes with solid toes shall be worn at all times.

Consumption of food and beverages in the labs is not permitted.

Wash hands and arms prior to leaving the laboratory.

2. Hazardous Chemicals

All containers must be labeled (including such harmless items as distilled water). The label should contain the proper name of the chemical and, if appropriate, a statement of hazards (with the most severe first), precautions, date of purchase or synthesis, and the name of the user.

Do not use chemicals from unlabeled containers. The need for adequate labeling extends far beyond the immediate requirements of the individual users, since they may not be present in case of fire or explosion, or when containers are broken or spilled. Also, they may no longer be associated with the laboratory years later when containers have deteriorated or otherwise lost their value. Prior to graduation each person must properly dispose of his/her waste or unwanted chemicals. All useful chemicals should be reassigned to another person who will assume responsibility. Proper labeling is extremely important as it is impossible to dispose of unlabeled chemicals.

Do not pipet by mouth. Never taste or smell any chemical.

Clean spills immediately! Small spills may be safely handled by lab personnel familiar with handling precautions for that material. EH&S has a special Hazardous Material Response Team and a fully equipped emergency vehicle to handle larger spills. If in doubt of your ability to handle the situation, evacuate the lab, close the door, and call 911 and explain the nature of the emergency.

Items that might cause thermal burns, such as furnaces or hot plates, must be posted with a **"HOT"** sign or other warning when in use but not attended.

Avoid direct contact with any chemical. What might be considered safe today may eventually be found to be harmful.

3. Transporting Chemicals

When chemicals are carried by hand, they should be placed in a carrying container or acid-carrying bucket to protect against breakage and spillage. When they are transported on a wheeled cart, the cart must have containment, i.e. no open wire carts. The cart should be stable under the load and have wheels large enough to negotiate uneven surfaces without tipping or stopping suddenly. Provisions for the safe transport of small quantities of flammable liquids include a) the use of rugged pressure-resistant, non-venting containers, b) storage during transport in a well-ventilated vehicle, and c) elimination of potential ignition sources. Chemicals should not be carried in open containers in hallways or elevators where they may be spilled.

4. Chemical Storage

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

It is the goal of the University to maintain the minimum amount of chemicals needed to conduct normal operations 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.

No more than 60 gallons of flammable solvent may be stored in an approved vented storage cabinet.

No more than 5 gallons of flammable solvent may be outside the approved storage cabinet in any single laboratory.

No flammable solvents may be stored in the hallways or offices at any time.

a. 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

Other Considerations:

- Use approved storage containers and safety cans for flammable 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.

b. Flammable Liquids

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

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.

c. Chemical Stability

See Appendix E for a list of chemicals that 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.

d. Shock Sensitive Chemicals

See Appendix E 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.

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

5. Chemical Spills

Chemical spills can be handled effectively if some preplanning has been conducted. Individuals should become familiar with cleanup procedures before a spill occurs. This preplanning should include consideration of:

- Potential locations of the spill.
- Quantities of material that might be released.
- Chemical and physical properties of the material (e.g., its physical state, vapor pressure, and air or water reactivity).
- Hazardous properties of the material.
- The types of personal protective equipment that might be needed.

a. Spill Kits

Cleanup material shall be available in the laboratory. These materials shall include:

i. Neutralizing agents such as sodium carbonate or sodium bisulfate.

ii. Absorbents such as vermiculite, paper towels, rags and sponges may be used, but caution should be exercised because some chemicals may ignite upon contact with them.

iii. Vacuum line and needle-nose pipette, and trap, for mercury spills.

b. Emergency procedures

If a spill does occur, the following general procedures may be used but should be tailored to individual needs:

i. Attend to any person who may have been contaminated.
ii. Notify individuals in the area about the spill.
iii. Evacuate nonessential personnel.
iv. If the spilled material is flammable, turn off ignition and heat source.
v. Avoid breathing vapors of spill material; if necessary, use a respirator.
vi. Leave on or establish exhaust ventilation if it is safe to do so. Please note that most air-handling units on campus are recirculating.

c. Spill Cleanup Procedures

Flammable liquids. All flames should be extinguished and spark producing equipment turned off. The spilled liquid should be absorbed and the absorbing material should be placed in a plastic bag and kept away from sources of ignition. This material should be disposed of in the same manner as all hazardous chemical waste.

Toxic chemicals. All flames should be extinguished, all spark-producing equipment turned off, and all experiments shut down. The room should be evacuated until it is decontaminated. In the case of volatile liquids or poisonous gases, respiratory protection should be worn when entering the room. Call EH&S for information on how to deal with a toxic chemical spill.

Acids or alkalies. Do not neutralize the spilled liquids unless you are sure that the resulting reaction will not release hazardous fumes or cause explosion. Otherwise neutralize the spilled liquid and absorb it.

Mercury spills. For small spills or well contained spills, gather mercury and put in a closed container (wear gloves). EH&S has a specially filtered mercury vacuum to pick up larger spills. Never use a regular vacuum, the mercury will contaminate the vacuum and release large quantities of Hg vapor whenever it is used. EH&S has instrumentation to measure Hg levels and will assist with decontamination procedures.

6. Glassware

a. Use only Pyrex or shatterproof glassware, and never use cracked or chipped glassware.
b. Insert tubing properly into stoppers (i.e., use lubricants such as a few drops of glycerine and always wear gloves).
c. Check with EH&S for information on proper disposal of broken glass, needles, and syringes. Each laboratory should have its own container for broken glass only. Broken glass that is contaminated with harmful materials must be disposed of separately: consult the department safety officer or the EH & S office for the proper procedure. Broken glass thermometers containing mercury should be

treated in the same way as a mercury spill. These should never be thrown in the broken glass container or trash receptacle.

C. Handling Gases and Gas Cylinders

See PSU Policy SY25 Compressed Gas Cylinders

1. General Handling Procedures

Cylinders of compressed gases high energy sources and should always be treated as such. Read and post "Sleeping Giant" (found in Appendix E).

2. Transport and Storage of Gas Cylinders

University policy (Policy SY25) mandates that you only use cylinders that meet Department of Transportation (DOT) regulations for the transportation and storage of compressed gases.

a. It is illegal to change the stamped marks on any compressed gas cylinder.
b. Carefully read the label and the MSDS before using or storing compressed gas.
c. Never move a cylinder with a regulator attached.
d. Never move or relocate a cylinder without having the safety cap securely in place.
e. When storing or moving a cylinder, the **cap must be securely in place** to protect the stem.
f. All cylinders shall be secured at all times (including empty cylinders and cylinders in transport). Use suitable racks, straps, chains or stands to support cylinders
g. Full and empty cylinders are to be stored separately.
h. Never expose cylinders to temperature extreme.
i. Flames should be kept as far away as possible from compressed gas cylinders.
j. All cylinder storage areas shall be so posted with the names of the gases being stored.
k. If gases of different types are being stored at the same location, the cylinders should be grouped by types of gas as follows:
   (i) toxic gases
   (ii) flammable gases
   (iii)oxidizing and inert gases

3. Withdrawing Cylinder Contents

Keep the following guidelines in mind during the withdrawing of gas from cylinder.

a. No cylinder is to be used if the contents are not known or identified.
b. Always use the correct regulator.
c. Do not use a regulator adapter.
d. Oil or grease on the high pressure side of an oxygen cylinder can cause an explosion.
e. Do not lubricate an oxygen regulator.
f. At no time should connections between cylinder and auxiliary equipment be forced. If the threads do not match, return the cylinder to General Stores.
g. Teflon tapes should never be used on cylinder or regulator connections.
h. When compressed gas cylinders are connected to a manifold, all related equipment should be of a design that has been approved by EH&S.
i. All cylinder valves should be opened slowly to prevent ice formation.
j. Before a regulator is removed from a cylinder, the cylinder valve shall be closed and all pressure released from the regulator and system.
k. No cylinders shall be recharged without special consent from the cylinder owner.

4. Cylinder Leaking

Should a cylinder leak, the following action should be taken:

a. Remove to a well ventilated area or outdoors.
b. Attempt to tighten the cylinder valve(s) or packing nut.
c. If above fails, attach a tag stating that the cylinder is unserviceable.
d. If the contents of the cylinder are flammable or toxic, place an appropriate warning sign in the area of the affected cylinder.
e. Immediately notify Environmental Health and Safety (EH&S) at 865-6391.

5. Flammable Gas Restrictions

a. No cylinders are to be stored near highly flammable solvents, combustible materials, unprotected electrical connections, gas flames, or other sources of ignition.
b. At no time shall a flame be used to detect a leak. A soapy water solution ("snoop") or approved commercial leak detection solution shall be used.

c. Inside buildings, stored oxygen shall be separated from flammable gas cylinders by a minimum of 20 feet, or separated by a fire resistant partition with a height no less than that of the cylinders.

6. Poison Gas Restrictions

a. Before using a poison gas, all label information and Material Safety Data Sheets (MSDS) associated with the use of the particular poison gas shall be read
b. All plans and procedures involving poison gas usage shall be reviewed and approved by EH&S prior to beginning use of the gas.
c. If EH&S determines that respiratory protection is required, respirator selection and training shall be done by EH&S.
d. Poison gases should only be used in force-ventilated areas, preferably in hoods with forced ventilation, or outdoors.
e. Poison as cylinders should be of a size that will ensure the complete usage of the cylinder within a reasonable period of time.

D. Equipment

1. Before using an instrument or machine, be certain all guards are in place before operation. Be sure you have been instructed and authorized by the person responsible for the equipment. Become familiar with potential hazards associated with the equipment, emergency shutdown procedures, as well as the operating procedures. Key hazards should be posted by each piece of equipment.
2. Check all electrical connections and mounting bolts before each use.
3. Check that all rotating parts are free to turn, and that there are no mechanical obstructions before starting.
4. Attach an "emergency shutdown procedure card" to any piece of equipment left operating unattended outside normal working hours. This card should contain your phone number and all information that would be required by anyone who might be faced with the need to shut down the equipment.
5. Laboratory equipment is not to be placed in corridors.

E. Vacuum Systems

Mechanical vacuum pumps used in laboratories pose common hazards. These are the mechanical hazards associated with any moving parts and the chemical hazards of

contaminating the pump oil with volatile substances and subsequently releasing them into the lab. A few guidelines will help in the safe use of these devices. Distillation or concentration operations requiring large concentrations of volatile substances should be performed using a water aspirator. If a vacuum pump is required for lower pressures, the pump must be fitted with a cold trap to condense the volatiles. The output of the pumps should be vented to a hood or alternate exhaust system. The pump oil should also be replaced when it becomes contaminated and disposed of by the chemical waste disposal guidelines presented later in this manual.

1. Be certain that your vacuum system has a trap.
2. Use only containers that can withstand evacuation. When possible, tape containers to be evacuated and use a standing shield to guard against implosion.
3. Always close the valve between the vacuum vessel and the pump before shutting off the pump to avoid sucking vacuum oil into the system.
4. All moving belts on mechanical pumps must have a safety cover.

F. Distillations and Condensers

Superheating and sudden boiling frequently occur when distilling under vacuum. Therefore it is important that the assembly be secure and the heat be distributed evenly (i.e. with a heating mantle or liquid bath). A standing shield should be in place to guard against implosion. An additional thermometer should be inserted near the bottom of the distilling flask to warn of a dangerous exothermic reaction. After finishing a vacuum distillation, cool the system before slowly bleeding in air, since air may induce an explosion in a hot system. Be sure that hoses carrying cooling water are securely attached with hose clamps to prevent accidental floods. Glass joints should be secured with clips available from the stockroom to prevent accidental disconnection or disconnection caused by vapor build up.

G Drying Ovens

Electric ovens are often used in laboratories for removing solvents or water from samples and to dry laboratory glassware. These ovens if not properly vented or used in a hood, discharge the volatile substances into the laboratory atmosphere which can accumulate in toxic concentrations. Small amounts of vapor can accumulate inside the oven and mix with the air to form explosive mixtures.

Do not transfer any materials from a solvent rinse directly to a drying oven without sufficient drying time. An explosion can occur if this is not observed. Ovens should not be

used to dry any chemical known to possess toxic vapors or that might volatilize and pose an explosion hazard or acute chemical hazard unless special precautions have been taken to ensure continuous venting to a hood. Organic compounds should not be dried in ovens whose heating elements or temperature controls (which may produce sparks) are exposed to the interior atmospheres. It is recommended to have blow out panels in the rear of a drying oven so that an explosion will not blow the door and contents into the lab. Bimetallic strip thermometers rather than alcohol or mercury thermometers should be used in ovens.

H. Heating Equipments

1. Steam Heated Devices

Steam-heated devices rather than electrically heated devices or bunsen burners shall be used whenever possible. Steam-heated devices do not present shock or spark hazards and can be left unattended with assurance that their temperature will not rise beyond $100^{O}C$.

2. Electrically Heated Devices

Only ***hot plates*** that have their heating elements enclosed in a glass, ceramic, or insulated metal case should be used in laboratories. Laboratory workers should be aware of the possible spark hazard from the on-off switch of older hot plates.

Heating mantles should be checked for breakage in the fiberglass cloth coating and to assure that no water or other chemicals are spilled into the mantle. Laboratory workers should be careful not to turn a variable transformer so high as to exceed the input voltage recommended for the mantle by the manufacturer.

Oil baths should always be monitored via a thermometer or other device to ensure that their temperature does not exceed the flash point of the oil being used. Smoking, caused by the decomposition of the oil or of organic materials in the oil represents another hazard. A laboratory worker using an oil bath heated above $100^{O}C$ should be careful to guard against the possibility that water (or some other volatile substance) could fall into the hot bath. Such an accident can splatter hot oil over a wide area. The oil bath should never be supported on an iron ring because of the possibility of accidental tipping.

3. Burners

Where burners are used, distribute the heat with a wire guard pad. As with all heating equipment, burners should not be left on when not in use. Workers should understand the hazards of burners before proceeding with the experiment.

I. Refrigerators

Three types of refrigerators are available for use.

1. The ordinary household refrigerator is not equipped with explosion-safe controls or door switches and should not be used to cool flammable liquids because sparks from control or door switches may ignite the vapor-air mixture.
2. The explosion-safe refrigerator is constructed with its controls mounted outside the storage compartment. This type refrigerator is suitable for storing flammable liquids.
3. The explosion-proof refrigerator also has its control mounted on the outside but, in addition, the control are of an explosion-proof design. This type is needed only where both the internal and external environment present a fire or explosion hazard.

Every refrigerator should be clearly labeled whether or not it is suitable for storage of flammable liquids. Flammable liquids stored in a refrigerator shall be closed containers. Laboratory refrigerators shall not be used for storage of foods or beverage unless used solely for that purpose and labeled as such.

J. Removal of Organics in Furnaces

When removing binders or other organic substances from ceramic powders prior to sintering, one must observe similar precautions to those discussed for drying ovens. During decomposition, binders breakdown into shorter chain molecules and volatilize from the sample. These decomposition products often contain carbon monoxide as well as other toxic gases. If not properly vented, these gases may pose acute or chronic toxicity hazards to people in the lab and they can also form explosive mixtures when combined with the furnace atmosphere. Prior to burning out any organic material in a furnace one should estimate the chemical composition of possible decomposition products and ensure the heating cycle and furnace atmosphere are properly controlled so that the explosive limits of the by-products are

not reached. The CRC Handbook of Chemistry and Physics lists explosion limits for some substances. If in doubt contact EH&S for additional assistance.

K. Chemical Fume Hoods

Chemical fume hoods are intended to remove vapors, gases and dusts of toxic, flammable, corrosive or otherwise dangerous materials. With the sash lowered to the indicated level for proper airflow, laboratory fume hoods can also afford workers protection from such hazards as chemical splashes or sprays and fires. However, they are not designed to withstand explosions.

The possible factors and guides should be observed in the daily operation of the fume hoods:

1. Before performing hazardous operations, make simple checks to determine that the hood is working (e.g., a small piece of paper held at the face of the hood will be sucked inward).
2. When work is being conducted within the hood, keep the sash at the recommended height. The work opening necessary to attain the proper inflow velocity is posted in your hood and updated annually by EH&S.
3. Experimental procedures should be conducted well inside the hood. Moving an apparatus 5-10 cm back from the front edge into the hood can reduce the vapor concentration at the face by 90%.
4. Hoods are not intended for the storage of chemicals. Materials stored in them should be kept to a minimum and in a manner that will not interfere with airflow.
5. Hoods should be considered as backup safety devices that can contain and exhaust toxic, offensive, or flammable materials. They should not be regarded as a means of disposing of chemicals.

The use of perchloric acid requires specially designed perchloric acid fume hoods. For the specifications of a perchloric acid fume hood, as well as the requirements and procedures for installation, repair, removal and relocation, consult the university policy on fume hoods (EH&S memo #81-1).

L. Housekeeping

Work areas shall be kept clean and free from obstructions. Cleanups should follow the completion of any operation or be done at the end of the day. Aisles, hallways and stairways shall not be used for storage areas.

All reagents stored in other than their original container shall be labeled clearly as to the contents, date and number of the person storing the solutions. Chemicals stored in the laboratory should be inventoried periodically and unneeded items either disposed of or returned to the store room. Containers should also be examined for deteriorating labels. The quality of chemicals stored in the laboratory shall be kept as low as possible.

Old or outdated solutions should be disposed of (see Section VII). The laboratory supervisor should arrange for the removal of safe storage of all hazardous materials which personnel have on hand when they are about to terminate, graduate or transfer.

All spills and broken glassware shall be cleaned up immediately (see Section V-B).

Never store bottles or equipment on shelves over laboratory benches unless there are restraining lips on the shelves. Storage of bottles on benches is undesirable because of their propensity to be knocked over. Storage in hoods is also inadvisable because this practice interferes with the airflow in the hood, clutters up the working space, and increases the amount of material that could become involved in a fire.

Wastes shall be placed in appropriate receptacles and properly labeled. Broken glassware, pipettes and syringes shall be placed first into puncture proof containers.

VI. CHEMICAL HAZARDS AND SAFETY PROCEDURES

The first step in using any chemical should be a review of the material safety data sheet supplied by the manufacturer, available from the department's safety coordinator, or obtained from the EH & S office or web page http://www.ehs.psu.edu. Pay specific attention to the potential hazards and safety equipment required for working with the material. Be familiar with the proper emergency procedures recommended for the chemical in case of accidental exposure.

A. Unattended Chemical Reactions

Take great care in setting up chemical reactions that are to be left unattended for any period of time. Note that unattended operation should be avoided if at all possible. The possible hazards that might arise from failure of a heating mantle (overheating), failure of a water cooling system (hose becoming disconnected or bursting), and failure of an exhaust (if flammable solvents or toxic gases are involved), are obvious points to check before leaving a reaction unattended. Any reaction that is left unattended should be clearly labeled as to the nature of the reaction and its components, the possible hazards (i.e., poisonous vapors), and the name and phone number of the experimenter. A notice describing the nature of the unattended experiment, emergency procedures, and who to contact in case of emergencies should be posted on the outside of the door to the laboratory in which the experiment is being conducted. Before leaving an unattended experiment, all temperature control/timing devices should be checked along with cooling water corrections and tubing.

Before beginning a chemical reaction the experimenter should have an idea of how it will proceed. Thus, ice baths can be ready if it is exothermic, a vent is available if gases are generated, automatic shutdown incorporated in the event of loss of electrical power, cooling water, etc. The experimenter should also notify his/her advisor that the experiment will be running overnight.

B. Toxic Hazards

Researchers should be aware of the toxic hazards of the materials they are using, and those being used by others in their vicinity. Toxic materials may enter the body through the skin, inhalation, and/or ingestion. Care should be taken to prevent these means of entrance when handling toxic materials. A large number of common substances are acute respiratory hazards and should not be used in a confined area in large amounts. They should be used only

in a hood. Some of these include; ammonium hydroxide, carbon monoxide, chlorine, fluorine, hydrochloric acid, hydrogen sulfide, and sulfur dioxide. These may form as by-products of certain reactions. Control of these by-products should be part of the experimental procedure.

C. Acids and Bases

Acids and bases are found in most laboratories since there are a variety of applications for them. Three important hazards are associated with acids and bases: chemical burns suffered from spills, inhalation of caustic vapors, and fires or explosions caused by strongly exothermic reactions occurring when strong acids are diluted rapidly. Strong bases may often cause more severe burns than acids as they don't often provide a warning, such as a burning sensation until damage to the skin has already occurred.

1. Always dilute acids by adding them to water and not vice versa.
2. Use dilute acids and bases whenever possible.
3. Keep bottles of strong acids and bases closed when not in use since they can react with moisture in the air to form caustic fumes.
4. If acids or bases are accidentally splashed in the eye or on the skin, flush with water immediately, continue flushing for 15 minutes, and call for help.

***Hydrofluoric Acid*.** Hydrogen fluoride (HF) is a very serious hazard since both its gas and solutions are extremely toxic and it is rapidly absorbed through the skin without immediate warning (such as a burning sensation), but causes long term excruciating pain and burns which take a long time to heal. If HF is used, a first aid HF gel should be in the lab first aid kit.

Prompt removal of contaminated clothing while the injured person is being flushed with water is essential. Continuous flushing with cool water is vital until any whitening of the tissue has disappeared. Cover the exposed area with wet, iced cloths and get immediate medical help. Do not apply any ointments. In all cases of contact with HF obtain medical aid. Simple flushing with water does not remove HF deep in the tissues and additional treatment is required.

***Perchloric Acid and Perchlorates*.** Cold perchloric acid has the properties of a strong acid. When hot it is also a strong oxidizing and dehydrating agent. It becomes unstable with time and will detonate under shock. Perchlorate compounds will often explode from heating, or from contact with flame, by impact, or friction, or spontaneously. Perchloric acid forms

explosive compounds with both organic and inorganic chemicals. Because of this, it must be used in a special ventilation hood equipped with water spray and wash down in which no other types of chemical reactions have ever been vented, and which is not lubricated with organic lubricants. It is imperative that no one attempts to store or use perchloric acid or perchlorate compounds without the prior knowledge, instruction, and supervision or approval of your advisor/supervisor. A safety review by the safety chairman and selected faculty prior to experimentation is recommended.

***Nitric acid*.** It is corrosive and its oxides are highly toxic. Because nitric acid is also an oxidizing agent, it may form flammable and explosive compounds with many materials (e.g., ethers, acetone and combustible materials). Paper used to wipe up nitric acid may ignite spontaneously when dry. Nitric acid should be used only in a hood and should be stored away from combustible materials.

***Picric acid*.** It can form explosive compounds with many combustible materials. When the moisture content decreases, picric acid may become unstable and may explode from being shaken. Picric acid should be dated, stored away from combustible materials and not kept for extended periods (i.e., longer than one year).

D. Organic Solvents

Many organic solvents possess harmful vapors or pose health hazards because they can be easily absorbed through the skin. Most solvents are quite volatile and the vapors are flammable. Always refer to the MSDS of a solvent before using it to become aware of the hazards, safety precautions, and emergency procedures associated with that specific solvent. Always store them according to the guidelines for storage of flammable liquids. A few examples of the hazards of some common solvents are provided below, but this list is by no means complete.

Acetone. Possesses toxic and flammable vapors. Use proper ventilation, safety glasses, and gloves. Store in a flammable liquids storage area.

***Methanol*.** Possesses harmful vapors that can cause dizziness, central nervous system depression, and shortness of breath. Severe exposure can lead to coma and eventually death. Less severe exposure can cause blurring of vision, conjunctivitis, headaches, gastrointestinal disturbances, and definite eye lesions. Methanol should be used in a ventilation hood and neoprene gloves should be worn.

Benzene. Carcinogenic. Chronic poisoning can occur by inhalation of relatively small amounts over a long time. Can also be absorbed through the skin. Vapors are flammable and it should be stored in a flammable liquids storage area.

Ethers. Ethyl ether, isopropyl ether, dioxane, tetrahydrofuran and many other ethers tend to absorb and react with oxygen from the air to form unstable peroxides which may detonate with extreme violence when they become concentrated by evaporation or distillation, when combined with other compounds that give a mixture that can be detonated, or when disturbed by unusual heat, shock or friction (sometimes as little as unscrewing the bottle cap). This class of compounds should be avoided if there is a safer alternative. It is generally recommended that ethers which will form peroxides should be stored in full, airtight, amber glass bottles, preferably in the dark, or in metal containers. Although ethyl ether is frequently stored under refrigeration (explosion proof), there is no evidence that refrigerated storage will prevent formation of peroxides. Furthermore, leaks can result in explosive mixtures even in refrigerators, since the flash point of ethyl ether is -45°C (-49°F).

E. Flammable Liquids

1. General Information

Flammable substances are the most common hazardous materials found in the laboratory. They propensity to vaporize, ignite, burn or explode varies with the specific type of class of substance. An indicator of the flammability of a solvent is its flash point, lowest temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air. This information is usually available on the label affixed to the chemical container or in tables of chemical data. Flammable liquids are defined as those liquids which have flash points below 100°F (37.7^{O}C). Combustible liquids have flash points between 100°F (37.7^{O}C) and 210°F (93.3^{O}C). Table 1 lists the properties of common chemicals with low flash points.

Among the most hazardous liquids are those that have flash points at room temperature or lower, particularly if their range of flammability is broad.

For a fire to occur, three conditions must exist: a concentration of flammable vapor that is within the flammable limits of the substance; an oxidizing atmosphere, such as air; and a source of ignition. Elimination of one of these three will prevent the start of fire or

extinguish an existing fire. Air usually cannot be excluded. Therefore, the problem usually involves preventing the coexistence of flammable vapors and an ignition source. Because spillage of a flammable liquid is always a possibility, strict control of ignition sources is mandatory.

When flammable materials are being used in a laboratory, close attention should be given to all potential sources of ignition. The vapors of all flammable liquids are heavier than air and capable of traveling considerable distances. This possibility should be recognized, and special note should be taken of ignition sources at a lower level than that at which the substance is used.

2. Handling

The following guidelines should be observed in handling flammable materials:

a. Flammable materials should be handled only in areas free of ignition sources.
b. "No Smoking" signs should be posted and obeyed wherever flammable liquids are. Never smoke or use an open flame near flammable liquids.
c. Flammables should not be heated with an open flame. Some other type of heat source, such as a steam bath, water bath, or heating mantle should be used.
d. Transfer flammable liquids with caution. The friction of flowing liquids may be sufficient to generate static electricity which in turn may cause a spark and ignition. Therefore, ground or bond all such large containers before pouring from them. (You may contact EH&S for the details of this procedure.)
e. Flammable liquids should be dispensed and used in a hood or well-ventilated area so that flammable vapors will not accumulate.
f. Substitute nonflammable liquids whenever possible.

F. Highly Reactive Chemicals and Explosives

When chemical reactions are considered safe, it is generally because the reaction rate is relatively slow or can be easily controlled. Certain reactions proceed, however, at such a fast rate and generate so much heat that they may result in explosion. Care should be taken to ensure there is sufficient cooling and surface area for heat exchange.

Many chemical reactions may involve hazards like those mentioned above, but can be handled safely if some preliminary planning has been done. Planning an experiment should

include knowledge of the reactivity, flammability and toxicity of the chemicals used in and produced by the experiment. This information may be obtained from such sources as the Fire Protection Guide on Hazardous Materials (NFPA) or by calling EH&S (865-6391).

Researchers should consult the laboratory supervisor or principal investigator when planning an experiment in which hazardous materials are used or hazardous conditions may occur. Such planning shall include selection of the proper safety procedures, clothing and equipment, as well as consideration of the possibility of a power failure, equipment breakdown, or fire, and the precautions that can be taken to minimize the consequences.

Organic peroxides are a class of compounds that have unusual stability problems that make them among the most hazardous substances handled in laboratories. As a class, organic peroxides are considered to be powerful explosives. They are sensitive to heat, friction, impact, and light, as well as to strong oxidizing and reducing agents. All organic peroxides are flammable. Suggestions for safe use and storage of ether and other peroxidizable materials:

- All peroxidizable materials should be stored in a cool place, away from light. Metal cans are preferable; do not store ethers in ground glass-stoppered bottles.
- Ethers and peroxidizable materials should be ordered only in small quantities and should be dated upon receipt and when opened. They should be discarded within a year after receipt if unopened, or within six months of opening.
- Ethers shall always be handled in a hood to assure proper ventilation. This will protect individuals from inhaling the vapors and prevent accumulation of explosive concentrations of the vapor. For methods of peroxide detection and removal, consult EH&S.

G. High Energy Oxidizers

Very small amount of strong oxidizers (0.25g) can result in severe explosions and must be handled with the proper protective equipment, such as: protective clothing, leather gloves and face shields. Larger amounts require special procedures involving explosion barriers. Specific procedures should be included in the MSDS for the chemical or by discussion with EH&S personnel.

Suggestions for safe use and storage:

- Oxidizing agents should be stored separately from flammable liquids, organics, dehydrating agents and reducing agents.
- Strong oxidizing agents should be stored and used in glass or other inert containers. Corks and rubber stoppers should not be used.
- Oxidizing agents should be used with caution in the vicinity of flammable materials.

H. Alkali Metals

Alkali metals react violently with water and decompose the water to give off hydrogen that may be ignited by the heat of reaction. Alkali metals can also ignite spontaneously in air, especially when the metal is in powdered form and/or the air is moist.

Suggestions for safe use and storage:

- Store alkali metals under mineral oil or kerosene. Avoid using oils containing sulfur since a hazardous reaction may occur.
- Use only special, dry powder fire extinguishers on alkali metal fires.
- Any waste alkali metals should be placed in a labeled, leak proof container, covered with mineral oil and disposed of via EH&S waste pickup service.

I. Powders

Most ceramic materials are considered inert with the human body however submicron particles in the lungs may cause respiratory irritation. Whenever working with fine powders correct respiratory protection is recommended. Cloth dust masks available in the stockroom are not appropriate for work with extremely fine powders. Some powders such as SiO_2, cause lung diseases such as silicosis. BeO and PbO are considered extremely toxic and must be handled with great care. If possible use powders in a hood so as to not contaminate the laboratory. The specific requirements for each powder are generally listed on the MSDS. Some fine powders are pyrophoric and may explode when dispersed in air. Periodic air samples for lead should be performed if there is a potential for air lead contaminants. Records of such testes must be kept on file in the EH&S offices.

J. Whiskers and Fibers

Since the cancer causing nature of asbestos was discovered, other mineral and ceramic fibers are under suspicion for their health hazards. It is not well known whether this health

risk involves a chemical or physical reaction in the body. Fibers and whiskers must be handled with care so that they may not be inhaled or brought into contact with the skin.

K. Toxic Substances

Toxicity is the capability of a chemical to produce injury. Almost any substance is toxic when taken in doses exceeding "tolerable" limits. Hazard is the probability that an injury will occur, or rather the prospect that an individual will receive a toxic dose.

The effects of a toxic chemical may be qualified into several categories. Local toxicity is the effect a substance has on the body tissues at the point of contact. Systemic toxicity is the effect a substance has on body tissues other than at the point of contact. Acute toxicity is the effect a substance has after only one or a few short, relatively large exposures. Chronic toxicity is the effect a substance has as a result of many small exposures over a long period of time.

An individual may be exposed to a chemical substance via a number of different routes:

- inhalation
- ingestion
- contact with skin or eyes

Inhalation of toxic vapors, mists, gases or dusts can result in poisoning by absorption through the mucous membrane of the mouth, throat, and lungs, and can cause serious local effects. Because of the large surface area of the lung (90 square meters total surface) along with its continuous blood flow, inhaled gases or vapors may be very rapidly absorbed and carried into the circulatory system. The rate of absorption will vary with the concentration of the toxic substance, its solubility and the individual inhalation rate. The degree of injury from exposure to a toxic substance depends on the toxicity of the material, its solubility in tissue fluids and the concentration and duration of exposure.

Ingestion of chemicals used in the laboratory may result in significant injury. The relative acute toxicity of a chemical can be determined by its oral LD_{50}, that quantity of material which when ingested, will cause the death of 50% of the test animals. This LD_{50} is expressed usually in milligrams per kilogram of body weight.

To prevent ingestion of chemicals, laboratory workers should wash their hands immediately after using any toxic substance and before leaving the laboratory. Food and drink should not be stored or consumed in areas where chemicals are being used. Cigarettes, cigars and pipes should not be used in other than specifically designated “safe” areas. Chemicals should not be tasted, and pipetting and siphoning of liquids should never be done by mouth.

Skin contact is the most frequent route of exposure to chemical substances. A common result of skin contact is localized irritation but some materials can be absorbed through the skin sufficiently to produce systemic poisoning. Contact of most chemicals with the eyes will result in pain and irritation. A considerable number of chemical substances are capable of causing burns or loss of vision. Alkaline materials, phenols and strong acids are particularly corrosive and may cause permanent loss of vision. Furthermore, the vascular network of the eyes may permit the rapid absorption of many chemicals.

All persons in the laboratory should wear safety glasses to prevent eye contact with chemicals. However, face shields, safety goggles, shields and similar devices will provide better protection. Protection against skin contact may be obtained by use of gloves, laboratory coats, tongs, and other protective devices.

VII. CHEMICAL WASTE DISPOSAL

See PSU Safety Policy SY20 Hazardous Waste Disposal

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

A. Chemical Waste Handling Policies and Procedures

The University has developed the following protocols to comply with requirements for proper chemical waste handling and disposal mandated from the Federal and State governments. Within the University Policy Manual, complete descriptions of Hazardous Waste handling procedures are available. The policy, entitled SY 20 Hazardous Waste Disposal, can be found in its entirety in the pages of the University GURU. The following information is being provided as an overview of the EMS College protocol.

1) **Every individual** who might handle laboratory waste must receive training procedures for chemical storage and waste management. Training will be provided by the Department, Institute, or EHS.
2) Individuals have been assigned to periodically review chemical storage and waste management operations in every laboratory.
3) In every laboratory where chemicals are used, an area designated for Chemical Waste Accumulation has been established.
4) A Principal Investigator or Faculty Member has been assigned overall responsibility for each laboratory.
5) A trained individual has been assigned to oversee chemical storage and waste management within the laboratory.
6) Phone numbers and email addresses of contact personnel are located on the door of each laboratory.
7) The proper collection and storage of waste chemicals are the responsibility of the generator. The following are the responsibilities of the generator:

    a. Insure that the composition of the waste container is compatible with the waste material. Insure the container is not leaking.
    b. Properly label and date the waste container, defacing the original label if it is not consistent with the contained waste material.

c. Properly segregate the waste materials. Chemicals should be segregated into the following categories: Flammables, corrosives, poisons and oxidizers.
d. Properly store in designated secondary containment vessels.
e. Properly fill out the appropriate Chemical Manifest form.
f. The individual assigned for oversight will contact EHS for waste materials removal.

B. Drain Disposal for Selected Chemicals

See PSU GURU Guideline SYGO1 Guideline for the Drain Disposal of Chemicals at: http://guru.psu.edu/policies/SYG01.html

Some waste chemicals have been approved for drain disposal. If the pH of the material is between 3 and 11, the following chemicals are approved for drain disposal:

Sulfuric Acid
Hydrochloric Acid
Phosphoric Acid
Sodium Hydroxide
Potassium Hydroxide

If the pH range is not met, dispose of the chemicals as a hazardous waste. Intentional dilution of these waste materials to meet the approved pH range for drain disposal is illegal.

Small amounts of the following chemicals are approved for drain disposal if they comprise no more than 2% of the final mixture:

Methanol	Ethanol
Propanols	Xylenes
Hexane	Toluene
Acetone	

Note: Please refer to Policy SY-20 for a complete description of approved drain disposal practices.

VIII. RADIATION HAZARDS

A number of acute and long term effects on humans have been related to exposure from various types of ionizing radiation. Radiation hazards arise when using radio-isotopes, lasers, x-ray generators and plasma torches. Each is hazardous in a unique way, and the precautions vary widely. Information pertaining to the particular hazard should be obtained from the faculty or research staff member in charge of the equipment prior to use, or from the Health Physics office (865-3459). However, several precautionary procedures should always be followed:

A. Radioactive Materials

1. All work with radioactive material or radiation producing equipment must be registered with the Health Physics Office. All persons using radioactive material and x-ray machines must be instructed in the potential hazards and the necessary safety precautions. Training sessions are offered regularly by the Health Physics Office and include a written exam to demonstrate that the personnel have been adequately instructed. All persons working with radioactive materials or equipment must obtain dosimeters from the Health Physics Office and complete the training session before beginning their work.

2. Do not wear another person's dosimeter or allow another person to wear yours.

3. Return your old dosimeter to the Health Physics Office immediately after receipt of new dosimeter (every 3 months) whether you used it or not. You will be charged for dosimeters returned more than 10 days after receipt of the exchange dosimeter and for lost or damaged dosimeters. Notify the Health Physics Office to terminate dosimeter service when you no longer need it or are leaving the university.

4. Review with the Health Physics Office any potential exposures to non-ionizing radiation such as ultraviolet, visible, infrared and microwave radiation.

5. Clearly mark areas in which lasers, ultraviolet, or high intensity light sources are in use.

6. Wear eye protection appropriate to the type of radiation being used when working with these sources. Consult EH&S to find out the correct type of protection for your work.

7. Remember that electron microscopes (SEM's and TEM's) are x-ray sources.

B. X-ray Equipment:

1. Under no circumstances should any part of the body be placed directly in primary x-ray beams.

2. Whenever possible turn the x-ray beam off before working on the machine. If this cannot be done, double check to be sure that the shutter on the port involved is closed.

3. Never align samples with the eye in such a position that it might be exposed to the primary beam.

4. Do not defeat any interlock devices, e.g. wiring shutters in the open position.

5. Do not use any x-ray machine that is not working properly.

6. Wear any required personnel monitoring devices at all times while using the x-ray machine.

7. Have the radiation levels around the x-ray machine checked anytime a configuration is used which has not previously been surveyed. The Health Physics Office will perform such surveys upon request (865-3459).

8. Report any suspected overexposures to the Health Physics Office immediately.

9. Do not depend upon lead foil or sheets for permanent shielding. Shields should be constructed of more durable materials. If lead is to be used it should be as a liner inside brass or some other material.

10. Remember the additional high voltage hazard associated with x-ray machines.

C. Lasers

There are many types and intensities of lasers and therefore only general guidelines are given.

1. Never look directly at the beam or pump source.
2. Never view the beam pattern directly; use an image converter or other safe, indirect means. To decrease reflection hazard, do not aim by looking along the beam.

3. Do not allow any object which could cause specular reflections in or along the beam. Such as spherical buttons, screw heads, or jewelry.

4. Keep a high general illumination level where lasers are in operation to cause contraction of pupils and reduced hazard.

5. Always wear goggles that offer protection against specific wavelength of the laser in use The EH&S office or laboratory instructor can provide information on the correct eyewear.

6. Post warning signs outside and inside the laboratory to warn of potential hazards. Clearly mark any areas where laser beams are in use.

D. Ultraviolet Lamps:

1. All radiation of wavelengths shorter then 3500 Å should be considered dangerous.

2. Protective safety glasses with UV absorbing lenses should be worn when the eyes may be accidentally exposed. The EH&S office or laboratory instructor can provide information on the correct eyewear.

3. Skin exposed to UV radiation can receive painful burns , analogous to sunburns and should be protected.

IX. ELECTRICAL HAZARDS AND SAFETY PROCEDURES

While electricity is in constant use by the researcher, both within and outside the laboratory, significant physical harm or death may result from its misuse. With direct current, a man can detect a "tingling" feeling at 1 mA and the median "let-go" threshold (the current at which he cannot release the conductor) is 76 mA. For 60 Hertz alternating current, the values are 0.4 mA and 16 mA, respectively. Women are more sensitive to the effects of electrical current; approximately 2/3 of the current is needed to produce the same effect. Higher currents produce respiratory inhibition, then ventricular fibrillation, and ultimately cardiac arrest.

If an electrical hazard is suspected, the device in question should be disconnected immediately and the cause ascertained by a person competent in such matters. Work on electrical devices should be done only after the power has been shut off in such a manner that it cannot be turned on accidentally. Since malfunctioning equipment may contain shorts, merely turning off the equipment is not sufficient to prevent accidents. Equipment should be unplugged before being inspected or the circuit the equipment is wired to deactivated by putting the circuit breaker in the off position or removing the fuse. Equipment wired to a safety switch should be turned off at the safety switch. Internal current-carrying devices such as capacitors must be discharged.

All "home-made" electrical apparatus must be inspected and approved by a qualified MatSE technician specified by Bob Frantz before being placed in service.

The following are a list of rules for working with electrical equipment:

1. Turn off the power to equipment before inspecting it. Turn off circuit breakers or unplug the equipment. To turn off a safety switch, use your left hand (wear insulating gloves made of leather or heavy cotton), turn your face away from the box, and pull the handle down. Circuits may discharge violently when being turned on or off and the cover to the junction box may be blown open.

2. Use only tools and equipment with non-conducting handles when working with electrical devices.

3. All current transmitting parts of any electrical devices must be enclosed.

4. When checking an operating circuit keep one hand either in a pocket or behind back to avoid making a closed circuit through the body.

5. Maintain a work space clear of extraneous material such as books, papers, and clothes.

6. Never change wiring with circuit plugged into power source.

7. Never plug leads into power source unless they are connected to an established circuit.

8. Avoid contacting circuits with wet hands or wet materials.

9. Wet cells should be placed on a piece of non-conducting material.

10. Check circuits for proper grounding with respect to the power source.

11. Do not insert another fuse of larger capacity if an instrument keeps blowing fuses - this is a symptom requiring expert repairs. If a fuse blows, find the cause of the problem before putting in another one.

12. Keep the use of extension cords to a minimum and cords as short as possible. Tie off excess cord out of pathways to avoid trip hazards.

13. Do not use or store highly flammable solvents near electrical equipment.

14. Multi-strip outlets (cube taps) should not be used in place of permanently installed receptacles. If additional outlets are required have them installed by an electrician.

15. Keep access to electrical panels and disconnect switches clear and unobstructed.

A. Static Electricity and Spark Hazards:

Sparks may result in explosions in areas where flammable liquids are being used and therefore proper grounding of equipment and containers is necessary. Some common potential sources of sparks are:

- The making and breaking of an electrical circuit when the circuit is energized.
- Metal tanks and containers.
- Plastic lab aprons.
- Metal clamps, nipples, or wire used with nonconducting hoses.
- High pressure gas cylinders upon discharge.

Grounding - In hazardous locations, all isolated metal parts of machines that may produce static electricity should be bonded and the machine grounded. Bonding is the act of electrically connecting two or more conducting objects with a conductor. Grounding is the process of electrically connecting one or more conducting objects to ground. In some countries grounding is referred to as "earthing."

The main purpose of bonding and grounding is to minimize potential differences between the metallic objects and between the objects and the ground. Bonding keeps two objects at the same potential; thus, no spark discharge can occur. Grounding the conducting object drains the static charges away as rapidly as they are produced. Thus, the threat of sparks is eliminated because there is no longer a difference in potential between the charged object and other nearby objects.

The current found in the bonding and grounding connections are on the order of microamperes. Because of the small currents involved, ground connections of low resistances are not essential. It is only necessary to have sufficient conductivity to carry off the charges before they build up to sparking potentials. A ground resistance as high as 1,000,000 ohms is usually adequate for static grounding.

Some objects such as a large steel tank resting directly on the ground need no special ground connection as they are inherently grounded.

X. CRYOGENIC SAFETY

A. When using a liquid nitrogen cold trap, charge the trap only after the system is pumped down. Since the boiling point of liquid nitrogen is -196°C and the boiling point of liquid oxygen is -183°C, liquid oxygen as well as volatile organic substances could condense in the cold traps. These mixtures may explode. When shutting down a system, charge the lines with nitrogen gas to prevent oxygen from entering the system.

B. Do not mix any organic material with liquid nitrogen for the reasons explained above. Wood and asphalt saturated with liquid oxygen has been known to explode when subjected to mechanical shock.

C. Handle any liquefied gas carefully: at extremely low temperatures it can produce an effect on the skin similar to a burn caused by a hot object. Eyes should be protected with a face shield and safety glasses. Only cryogenic gloves should be worn when handling liquid gases such as nitrogen and helium.

D. Stand clear of the boiling and splashing liquid and its issuing gas. Should any liquefied gas contact the skin or eyes, immediately flood that area of the body with large quantities of unheated water and then apply cold compresses.

E. Large quantities of liquid nitrogen can condense oxygen and thus remove it from the air. Use liquid nitrogen only in a well ventilated area so that the ambient oxygen concentration does not drop lower than 16% (the same applied to liquid helium).

F. High pressure gas hazards are always present when cryogenic fluids are used as they are usually stored at their boiling point. Never obstruct the vent valve on cryogenic containers.

G. Although many gases in the cryogenic range are not toxic, they are all capable of causing asphyxiation by displacing the air necessary to support life. Therefore, they should be used only in well ventilated areas.

An excellent reference which is strongly recommended for anyone working with cryogenic materials, is: Safety with Cryogenic Fluids, Michael G. Zabetakis, Plenum Press, New York, NY, 1967.

XI. FIRE SAFETY RULES

A. Precautionary Procedures

1. Know the location of fire exits, fire alarms, fire blankets and extinguishers. Appendix A of this manual contains a floor plan which pinpoints the location of each of these in Steidle Building. Each laboratory should be equipped with extinguishers. Fire extinguishers are primarily for use on fires in their incipient stages. Make it your business to learn about the proper use of fire extinguishers. See the following Guide to Classes of Fires.

2. Keep all fire doors closed at all times.

3. Do not block access to fire escape routes.

4. Neatness prevents many fires. Fire spreads much faster when it has cluttered waste materials to feed on. Oily rags, waste or papers improperly stored are common causes of spontaneous combustion. Store these materials in covered metal containers. Overloaded electrical circuits are potential fire hazards. Flammable vapors can ignite far away from their source and thus should be vented properly.

B. Emergency Procedures

1. If a fire starts, activate the nearest fire alarm box then call for assistance from a safe location by dialing 911. If the fire is not too large, confine and try to extinguish it with the proper type of extinguishers in the lab. Never jeopardize your personal safety in trying to extinguish a fire.

2. If there is no injury, and the fire is contained in a vessel, it can usually be suffocated by covering the vessel with a non-flammable object. Do not use towels or clothes. Remove nearby flammable materials to avoid possible spread of fire. If the fire is over an area too large to be suffocated quickly and simply, abandon the fire.

3. If evacuation is necessary, and if time allows, shut off power to any equipment. Shut off gas or other open flames. Turn off hot plates and main gas valves.

4. If your clothes ignite, "stop, drop and roll," to smother the flames. Do not run: running only intensifies the flames. When fire blankets are readily available, use them to wrap around yourself to aid in putting out the fire. Call for help.

5. Exit from the building via staircases; do not take elevators. Remove any objects that may be obstacles in passageways or to fire doors. Do not return to the building unless permitted to do so by the Fire Department.

C. Electrical Fires

1. Turn off power source at the breakers or the junction box and unplug.
2. Use CO_2, or dry chemical extinguisher to put out fire. Never use water.
3. Do not turn on circuit until appropriate officials have established the cause of fire, and the fault has been corrected.
4. Report fire to Safety Office.

D. Classes of Fires and Methods of Extinguishment

1. Class A Fire

Material: Wood, paper, textiles and other ordinary combustible materials.
To extinguish: Pressurized water, Multi-purpose dry chemical, Halon

2. Class B Fire

Material: Flammable liquids: oils, solvents, grease, paint, etc.
To extinguish: BC dry chemical, Carbon dioxide, Halon

3. Class C Fire

Electrical Fires
To extinguish: Carbon dioxide, Halon, BC dry chemical.

4. Class D Fire

Material: Metals: Magnesium, Aluminum, Sodium, Potassium, Zirconium, Titanium etc.
To extinguish: Special metal extinguishers. The ordinary extinguishers found in the building should not be used on metal fires because a violent reaction may result.

XII. REFERENCES

1. The Merck Index, Merck Pharmaceutical Company.

2. Dangerous Properties of Industrial Materials, 4th ed., N. Irving Sax, ed., Van Nostrand Pub. Co.,
3. New York, 1978.

4. Toxic and Hazardous Industrial Chemicals Safety Manual, International Technical Information
5. Institute, 1978.

6. Prudent Practices for Handling of Hazardous Chemicals in Laboratories, National Academy
7. Press, Washington, D.C., 1981.

8. Prudent Practices for Disposal of Hazardous Chemicals from Laboratories, National Academy
9. Press, Washington, D.C., 1983.

10. Occupational Health Guidelines for Chemical Hazards, NIOSH-OSHA, Jan., 1981.

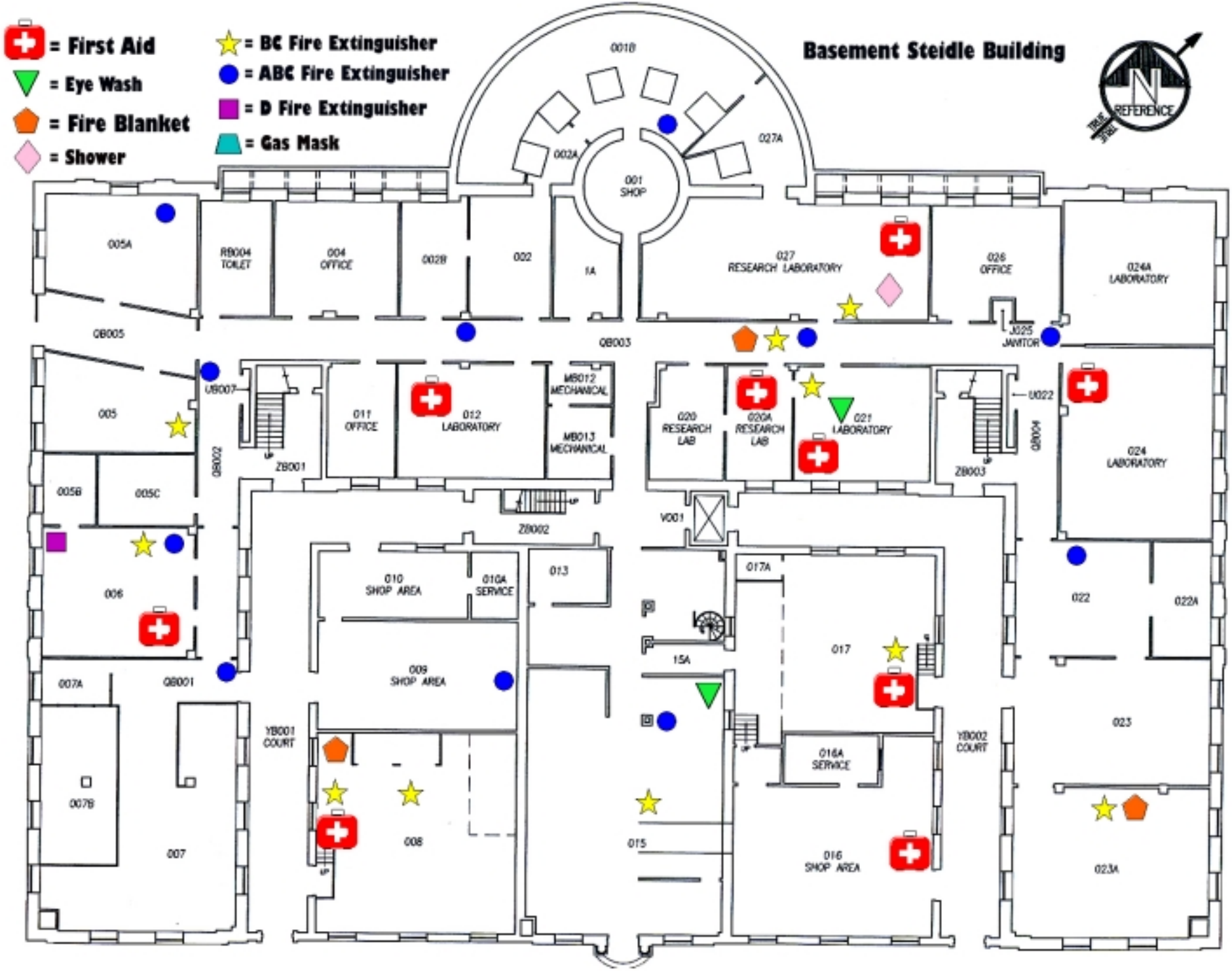
11. Materials Safety Data Sheets published by chemical manufacturers are available through the
12. safety office.

13. Safety in Academic Laboratories, American Chemical Society, 1155 16th St. N.W., Washington, D.C., 1979.

APPENDIX A

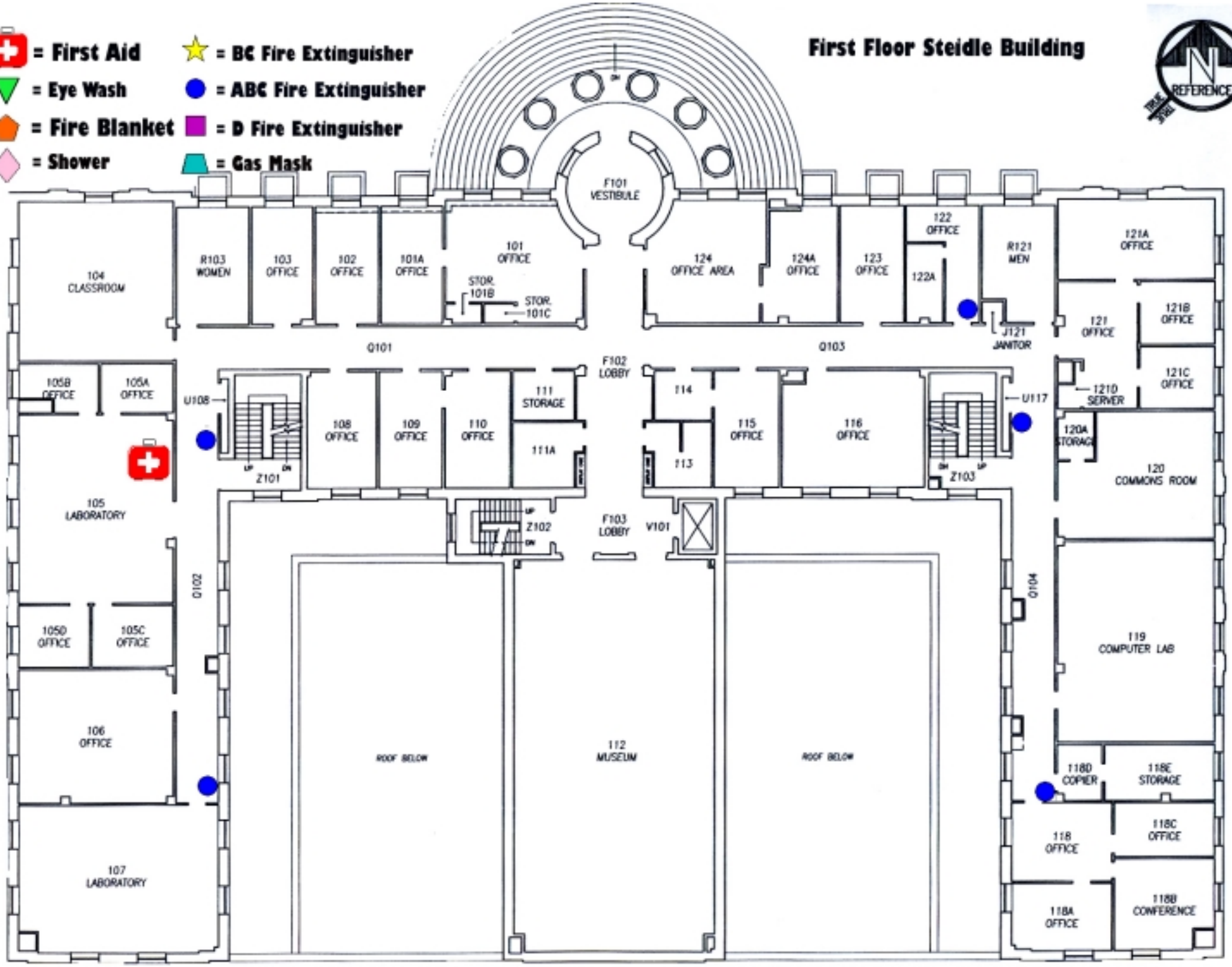
Floor Plans of Steidle Building Exhibiting the Location of Fire Extinguishers, Eye Wash Stations, and Fire Blankets

Basement Steidle Building



First Floor Steidle Building

= First Aid
= Eye Wash
= Fire Blanket
= Shower
= BC Fire Extinguisher
= ABC Fire Extinguisher
= D Fire Extinguisher
= Gas Mask

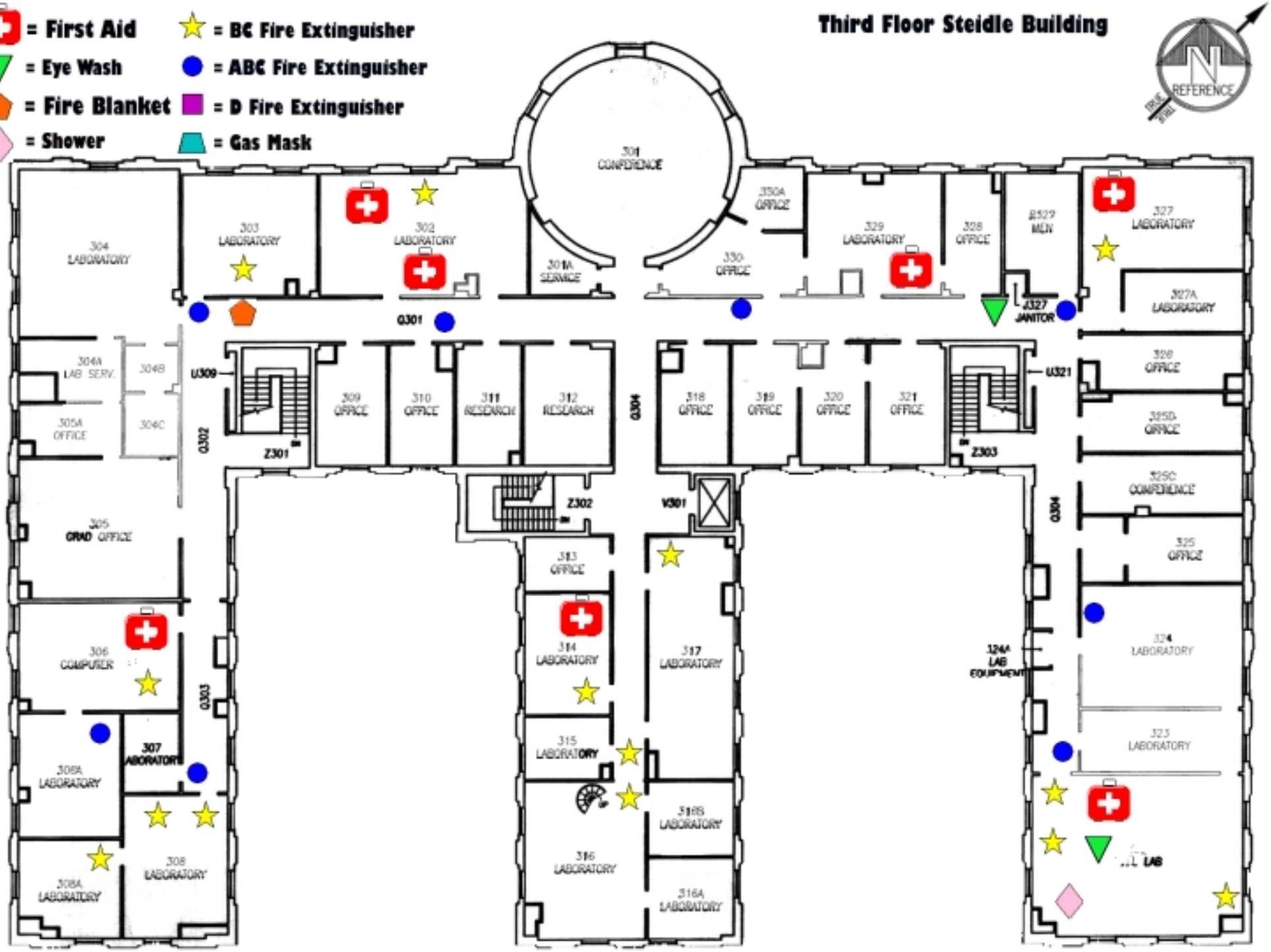


= First Aid
= Eye Wash
= Fire Blanket
= Shower
= BC Fire Extinguisher
= ABC Fire Extinguisher
= D Fire Extinguisher
= Gas Mask

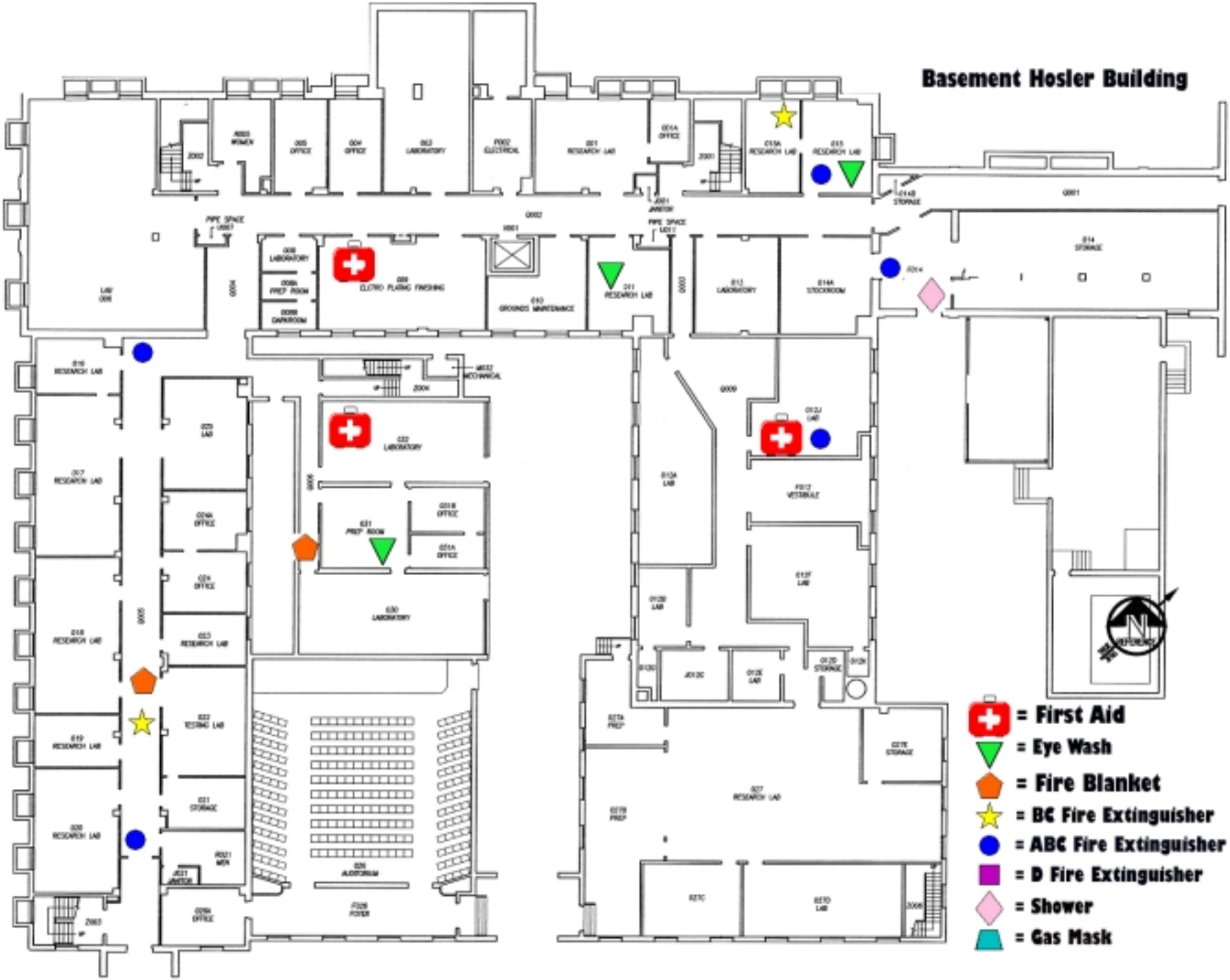
Second Floor Steidle Building

= First Aid
= Eye Wash
= Fire Blanket
= Shower
= BC Fire Extinguisher
= ABC Fire Extinguisher
= D Fire Extinguisher
= Gas Mask

Third Floor Steidle Building



Basement Hosler Building



CONTINUED AT FIRST FLOOR PLAN
ACADEMIC PROJECTS BUILDING NO. 0407-000

APPENDIX B

Example Material Safety Data Sheet (MSDS)

Revised: 1/11/99

1. Chemical Product and Contact Information

Product Name: Abrasive Paper Rolls, Silicon Carbide

Part Numbers:
810-086 810-087
810-088 810-089
810-090 810-091
810-095 810-097
810-098
810-734-200 810-735-200
810-736-200 810-737-200

LECO Corporation
3000 Lakeview
St. Joseph, Michigan 49085
Information: 616-983-5531
Chemtrec: 800-424-9300
(Chemtrec Int'l: 703-527-3887)

2. Composition/Information on Ingredients

Component	CAS No.	OSHA PEL (mg/m³)	ACGIH TLV (mg/m³)	Typical % by Weight
Silicon Carbide	409-21-1	15 (total dust)	10 (total dust)	60
Backing	Paper	Not avail.	Not avail.	30
Binder System	Mixture	Not avail.	Not avail.	10

3. Hazard Identification

EMERGENCY OVERVIEW

No significant fire or spill hazard; nuisance-level health hazard. Paper coated with abrasive material.

Potential Health Effects

EYES: Dust may irritate.
SKIN: Not absorbed though skin; may cause abrasions.
INHALATION: Acute dust - May cause coughing, shortness of breath - Chronic dust - may effect breathing capacity.
INGESTION: No known adverse effects, but ingestion not recommended.
MEDICAL CONDITIONS AGGRAVATED: Not available.
CHRONIC OVEREXPOSURE: Not available.
ACUTE OVEREXPOSURE: During use on some materials elevated sound levels may be created which affect hearing.

CARCINOGENICITY: None.

4. First Aid Measures

EYES: Wash with large amounts of water. Obtain first aid or medical assistance, if needed.
SKIN: Obtain first aid or medical assistance, if needed.
INHALATION: Remove to fresh air; apply artificial respiration as needed. Obtain first aid or medical assistance, if needed..
INGESTION: Obtain first aid or medical assistance, if needed.

5. Fire Fighting Measures

FLAMMABLE PROPERTIES: Non-flammable.
Flash Point: None. Method Used: Not applicable.
Flammable Limits (% by Volume in Air):
Lower: None. Upper: None.
AUTO-IGNITION TEMPERATURE: Not applicable.
HAZARDOUS COMBUSTION PRODUCTS: Not available.
EXTINGUISHING MEDIA: Not available.
FIREFIGHTING INSTRUCTIONS: Backings and resin binder will burn or decompose; use respiratory protection.

6. Accidental Release Measures

SMALL/LARGE SPILL: Normal clean-up procedures.

7. Handling and Storage

HANDLING: Handle with adequate ventilation. See OSHA 29 CFR 1910.94 (Ventilation) and 29 CFR 1910.1000 (Air Contaminants).
STORAGE: Keep container closed.

8. Exposure Controls/Personal Protection

ENGINEERING CONTROLS: Local or mechanical ventilation recommended.
RESPIRATORY PROTECTION: As needed, approved dust respirator OSHA 24 CFR 1910.134.
SKIN AND HAND PROTECTION: As desired by user.
EYE AND FACE PROTECTION: Recommend OSHA 29 CFR 1910.133 (Face & Eye Protection).
OTHER PROTECTIVE EQUIPMENT: As needed, hearing protection - OSHA 29 CFR 1910.215 (Hearing Protection).

9. Physical and Chemical Properties

APPEARANCE: Coated abrasive product.
BOILING POINT: Not available.
FREEZE-MELT POINT: Not available.
VAPOR PRESSURE (mm): Not available.
VAPOR DENSITY (air = 1): Not available.
SOLUBILITY IN WATER: Not available.
SPECIFIC GRAVITY: Not available.
pH: Not available.
ODOR: None.
PERCENT VOLATILES: Not available.
EVAPORATION RATE (Butyl Acetate = 1): Not available.

10. Stability and Reactivity

CHEMICAL STABILITY: Stable.
INCOMPATIBILITY: Not available.
HAZARDOUS DECOMPOSITION PRODUCTS: In use, dust and decomposing resin system fumes are generated. In most cases, the material removed from the work piece will be significantly greater than the coated abrasive product components.
HAZARDOUS POLYMERIZATION: None.

11. Toxicological Information

None reported.

12. Ecological Information

Not available.

13. Disposal Consideration

Standard landfill methods consistent with applicable Federal, State, & Local laws.

14. Transportation Information

U.S.A. DOT: Not regulated.

15. Regulatory Information

U.S. FEDERAL REGULATIONS:

TSCA STATUS: On Toxic Substance Control Inventory.

CERCLA REPORTABLE QUANTITY: None.

SARA TITLE III:

Section 302 Extremely Hazardous Substances: None.

Section 313 Toxic Chemicals: None.

RCRA STATUS: Not regulated.

CANADIAN REGULATIONS:

WHMIS: Not regulated.

16. Other Information

Hazard Index: (0 - 4, 4 = Extreme)

Health: 1 Fire: 0 Reactivity: 0

Prepared By:

Duane Ostenson

Information herein is given in good faith as authoritative and valid; however, no warranty, expressed or implied can be made.

APPENDIX C

Chemical Waste Manifest Form
and
Chemical Waste Disposal Procedure for PSU

Chemical Storage and Waste Management in Research and Teaching Laboratories

The following protocols have been established to ensure that all research and teaching laboratories comply with Federal- and state-mandated requirements for accumulation of chemical waste. Specifically, chemical waste must be contained in designated accumulation areas using secondary containment pans, and waste must be labeled and disposed of regularly. Weekly and periodic reviews of chemical storage and waste management must be conducted in each accumulation area, and all persons who handle chemical waste must be trained in safety procedures for chemical storage and waste management. Laboratory chemicals must be reviewed annually.

Records must be maintained in each laboratory to document that individuals have been trained and that weekly and annual reviews are being conducted. Please use the forms below to maintain documentation for your laboratory.

Form 1. Waste Management Log Book

Designated Accumulation Area

- building and room number where waste will be accumulated
- specific room location where waste containers will be maintained (i.e. “corner lab bench”)

Principal Investigator and E-mail

- name and e-mail address of person responsible for the laboratory (faculty member or PI)

Individual Assigned to Oversight

- name and e-mail address of person assigned to oversee chemical storage and waste management in the laboratory

Form 2. Chemical Storage and Waste Management Acknowledgement of Worker Instructions

Every individual who will handle laboratory waste must receive training in the safety procedures for chemical storage and waste management listed on Form 2. Each individual will sign this form when he/she has

completed training; the original will be maintained by the department, and a copy of each signed form should be included in the laboratory log book.

Spill Response Procedure: Do not try to clean up any spill that you feel uncomfortable with. Call Environmental Health and Safety (865-6391) and contact your building safety officer.

For large spills and emergencies, call 911.

Form 3. Individuals Trained to Handle Laboratory Waste

This form should list all individuals trained to handle waste in this laboratory. Copies of Form 3 should be sent to the department and to Environmental Health and Safety (EH & S). A copy of Form 2 (Acknowledgement of Worker Instructions) for each person on this list should be kept in the log book. Add new names and e-mail addresses as additional individuals are trained.

Form 4. Waste Accumulation Area Chemical Waste Review Log

A chemical waste review must be conducted weekly. Each week, the individual assigned to oversight in the laboratory must conduct a review and document the following areas on the review log:

Date Checked: date the review is conducted
Labeled Properly: make sure that each chemical waste container is labeled and that the information on the label is correct. Original labels, if not consistent with waste content, need to be removed or defaced.
Segregated Properly: make sure that chemical waste is segregated according to hazard: flammables separate from bases separate from acids.
Not Leaking: make sure that chemical units are placed in secondary container, are capped and are not leaking
Secondary Containment in Place: make sure that waste is placed in designated and labeled plastic pans
55 Gallon Storage Limit Not Exceeded: make sure that no more than 55 gallons of waste are being stored.
Signature of Laboratory Overseer: after the review is conducted and any problems are corrected, the laboratory overseer should sign the log.

Form 5. Annual Review of Chemicals

All chemicals stored in the laboratory must be reviewed annually to assure they are not exceeding their expiration dates or safe storage. This log documents whether the chemical was retained or disposed of based on this review. Reasons for retaining the chemical past the expiration date should be noted on the log. The log should be signed and dated when the annual review is conducted.

All chemicals purchased and maintained in the lab should be dated when opened. In order to simplify the annual reviews, new chemicals should be added to this list when opened.

Form 6. Chemical Waste Disposal Manifest Form

Use this form to request removal of chemical waste from the laboratory. Information on how to properly fill out the form will be provided at the training session.

This form can be completed and submitted via the Environmental Health and Safety (EH & S) web site: www.ehs.psu.edu

Fill out the form, print two copies, and submit the form to EH & S electronically via their web site. Retain one printed copy in the log book, and put one copy with the chemicals to be picked up.

Form 7. SY 20 Hazardous Waste Disposal Policy

This is the University Policy for Hazardous Waste Disposal. A copy should be retained in this log book.

Labels

A standard labeling system will be used for all chemical waste. These labels will be provided by Environmental Health and Safety. Instructions for use will be provided.

Secondary Containment in Plastic Pans

Standard containment pans will be used in the laboratories. The pans will be uniform in color and design.

Waste Management Log Book

A Waste Management Log Book should be maintained in each laboratory and kept with the secondary containment pans. The log books will be standardized.

Environmental Health and Safety Laboratory Information

This information will be provided by Environmental Health and Safety, and a copy should be maintained in each research laboratory.

Emergency and Laboratory Safety Phone Numbers

This form should be completed for each laboratory and located on the wall inside the entrance to the laboratory. Update the form when contact information changes.

Laboratory Information Form

This form should be completed and located on the outside door to the laboratory. Update the form when contact information changes.

11/99

Chemical Storage and Waste Management

Acknowledgement of Worker Instructions

I hereby acknowledge having received instructions on the safety procedures for chemical storage and waste management, including:

· log book documentation · proper labeling · proper segregation · non-leaking chemicals · chemical containers kept closed when not in use · storage limits · chemical review	· self audit · secondary containment · waste disposal procedure (SY 20) · spill/emergency response procedures · use/selection of PPE (Personal Protective Equipment)

Specific training topics:

- Plan to designate specific location of waste accumulation area within your lab
- Ensure documentation is maintained; check labeling, non-leaking chemicals, storage, and containment limits weekly
- How to obtain chemical manifest form and proper procedure for disposal of chemicals
- Segregation of chemicals into categories: flammable, bases, and acids in separate Rubbermaid storage pans
- Chemicals are labeled and closed when not in use
- Storage limit (55 gallons) not exceeded
- Spill/ emergency response procedures
- Use/selection of PPE (Personal Protective Equipment)
- Review chemicals annually: document date reviewed, whether chemical is retained or disposed of, and explanation
- Self-audit established by your research group.

_____

Name of Employee Trained (print) Signature of Trained Employee

_____ _____

Date of Training

Social Security Number

_____

Name of Trainer

Form 2 11/99

CHEMICAL MANIFEST FORM

Instructions and example on back.

College or Department_____

Building_____ Room_____

Generator's Name_____

Contact Person_____

Phone Number_____ E-Mail_____

Pick-up Point_____

RETURN TO:
Environmental Health & Safety
6 Eisenhower Parking Deck
University Park, PA 16802
Phone # (814) 865-6391
Fax # (814) 863-7427

*Submittal Date*_____

Name	CAS #	% of Total	AMT	Container Size	For EH&S Use Only ID#	Hazard

DATE PICKED UP_____ PICKED UP BY_____ INPUT DATE / INITIALS_____

Chemical Redistribution:

If you would like to receive clean or unused chemicals, when available, through our chemical redistribution program, please list them below. This service is free of charge and we will deliver the chemicals to any location at University Park and the neighboring areas. This program reduces purchase and disposal costs, so please consider using materials from the chemical redistribution program.

_____ _____ _____

_____ _____ _____

Please help the waste minimization program by purchasing only what you need to use.

APPENDIX D

Employee "Right to Know" Program
and
List of Definitions

Under the Pennsylvania "**Right to Know**" Act we are required by law to post the following:

Employee Workplace Notice

This and other helpful safety information can be found on the red, safety bulletin boards in room 120 (Student/Common Room) and in the undergraduate laboratory on the second floor of Steidle Building.

DEFINITIONS

ACUTE – An adverse effect on the human body with symptoms of high severity coming quickly to a crisis.

ALLERGIC SENSITIZATION – A condition acquired through exposure to a particular substance; additional exposure causes a more severe reaction.

BRONCHITIS – The inflammation of one or more of the larger passages leading to the lungs.

CARCINOGEN – A substance that has been shown to cause malignant (cancerous) tumors.

CHRONIC – An adverse effect on the human body with symptoms that develop slowly over a long period of time or which frequently recur.

CONJUNCTIVITIS – The inflammation of the delicate membrane lining the eyelids and covering the eyeball.

CYANOSIS – A bluish discoloration of the skin, especially on the face and fingers indicating a lack of sufficient oxygen in the blood.

DERMATITIS – An inflammation of the skin.

EVAPORATION RATE – A measure of the length of time required for a given amount of substance to evaporate normally compared with the time required for an equal amount of ether or butyl acetate to evaporate.

FLAMMABLE LIMITS – (Explosive limits)
Lower Flammable (Explosive) Limit – The lowest concentration of a combustible or flammable gas or vapor in the air that will produce a flash of fire. Mixtures below this concentration are too "lean" to burn.

Upper Flammable (Explosive) Limit – The highest concentration of a combustible or flammable gas or vapor in the air that will produce a flash of fire. Mixtures above this concentration are too "rich" to burn.

FLASH POINT – The lowest temperature, in Fahrenheit, at which a liquid will give off enough flammable vapor to ignite.

INGESTION – The taking in of a substance through the mouth.

INHALATION – The taking in of a substance by breathing.

LAVAGE – The washing or irrigation of an organ.

MUTAGEN – A substance that causes changes in the genetic materials in cells. Many carcinogens are also mutagens.

NARCOSIS – An unconscious state caused by a drug.

APPENDIX E

Shock Sensitive Chemicals
and
Explosive Peroxides
and
A Sleeping Giant

Shock Sensitive Chemicals

Shock sensitive chemicals are chemicals which can rapidly decompose or become explosive when struck. Below is a list of some common shock sensitive chemicals. Please refer to the MSDS for all chemicals in your laboratory to determine if they are indeed shock sensitive.

aluminum ophorite explosive
amatol
ammonium nitrate
ammonium perchlorate
ammonium picrate
ammonium salt lattice
calcium nitrate
cetylides of heavy metals
copper acetylide
cyanuric triazide
cyclotrimethylenetrinitramine
dinitroethyleneurea
dinitroglycerine
dinitrophenol
dinitrophenolates
dinitrotoluene
dipicryl sulfone
dipicylamine
ead mannite
erythritol tetranitrates
explosive mixtures
fulminate of mercury compounds
fulminate of silver
fulminating gold
fulminating mercury
gelatinized nitrocellulose
germane
guanyl nitrosamino guanylidene hydrazine
guanyl nitrosamino guanyltetrazene
heavy metal azides
hexanitrodiphenyl-amine
hexanitrostilbene
hexite
hydrazinium nitrate
hyrazoic acid
lead azide
lead mannite
lead picrate
lead salts
lead styphnate
magnesium ophorite
magnesium ophorite
mercury oxalate
mercury tartrate
mononitrotoluene
nitrated glucoside
nitrated polyhydric alcohol
nitroaminotetrozole
nitroaminotetrozole
nitrogen tri-iodide
nitrogen tri-iodide
nitrogen trichloride
nitroglycide
nitroglycol
nitroguanidine
nitroparaffins
nitroparaffins
nitrourea
organic amine nitrates
organic nitramines
organic peroxides
organic peroxides
picramide
picratol
picric acid
picryl chloride
picryl chloride
polynitro aliphatic compounds
potassium nitroaminotetrazole
silver acetylide
silver azide
silver tetrazene
sodatol
sodium amatol
sodium dinitro-ortho-cresolate
sodium picramate
syphnic acid
tetranitrocarbazole
tetrazene
tetrytol
trimethylolethane
trimonite
trinitroanisole
trinitrobenzoic acid
trinitrocresol
trinitronaphthalene
trinitrophenetol
trinitrophenetol
trinitrophloro-glucinol
trinitroresorcinol
trinitrotoluene
trintrobenzene
trintrobenzene
tritonal
urea nitrate
urea nitrate

Producers of Explosive Peroxides

Explosive Peroxides can be formed as a chemical decomposes with time. The list below is a brief compilation of some chemicals which can decompose producing explosive peroxides. This list in NOT complete. Please refer to the MSDS of all of the chemicals in your laboratory to determine if you have any shock sensitive chemicals.

Acetal	divinyl acetylene
cyclohexene	ethyl ether
decahydronaphthalene	ethylene glycoldimethylether (glyme)
diacetylene	isopropyl ether
dicyclopentadiene	methyl acetylene
diethyl ether	terahydronaphthalene
diethylene glycol	tetrahydrofuran
dimethyl ether	vinyl ether
dioxane	vinylidene chloride

A Sleeping Giant

I am a compressed gas cylinder. I weigh in at 175 pounds when filled.
I am pressurized at 2,200 pounds per square inch (psi).
I have a wall thickness of = 1/4 inch.
I can stand 57" tll.
I am 9 inches in diameter.
I wear a cap when not in use.
I wear valves, gages, and hoses when at work.
I wear many colors and bands to tell what tasks I perform.
I transform miscellaneous stacks of material into glistening ships and many other things when properly used.
I transform glistening ships and many other things into miscellaneous stacks of material when allowed to **unleash my fury unchecked**.
I am **ruthless and deadly** in the hands of the careless or the uninformed.
I am too frequently left standing alone on my small bases, my cap removed and lost by an unthinking workman. Then I am ready to be toppled over, my naked valve can be snapped off, and all my power can be unleashed through an opening no larger than a lead pencil.

I am proud of my capabilities - here are a few of them:

- I have been known to jet away faster than any dragster.
- I smash through brick walls with the greatest of ease.
- I fly through the air and reach a distance of half-a-mile or more.
- I spin, ricochet, crash and slash through anything in my path.
- I scoff at the puny efforts of human flesh, bone, and muscle to change my erratic course.
- I can, under certain conditions, rupture or explode – you read of these exploits in the newspapers.

You can be my master only under my terms:

- Full or empty, see to it that my cap is on straight and snug.
- Never, repeat **never** leave me standing alone. Keep me in a secure rack or tie me so that I cannot fall.