PennState

Laboratory Safety Manual

Department of Materials Science & Engineering

SAFETY FIRST. OUR DEPARTMENT IS COMMITTED TO A SAFE WORKPLACE FOR ALL.

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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

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 this manual together. 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 on-campus, which are unfortunately 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 for the benefit of ourselves 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.

Note that all MatSE laboratory course students, researchers, staff and faculty members must read this manual and pass the MatSE safety exam before working in any MatSE laboratory or being given access to Steidle Building and the laboratories within Steidle Building.

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 personnel 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. All members are required to pass a departmental safety exam before being granted access to any department facilities (see http://www.matse.psu.edu/safety for information on completing this requirement).

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

   a. Students in MatSE laboratory classes and others who are always supervised by a trained individual are required to pass the department safety exam
   b. Any researcher working independently in the laboratory must also take and pass the EHS Laboratory Safety and Laboratory Hazard Communication Training course (https://apps.opp.psu.edu/ehs_training/course_list.cfm)
   c. Additional training may be required for specific hazards (e.g., LASER safety training or x-ray safetytraining)

C. Each laboratory space has a Laboratory Safety Manager (LSM) whose responsibility it is to manage the safety-related documentation for that lab and ensure that everyone working in the lab has taken the appropriate safety training. The LSMs are also responsible for disseminating safety-related information to their research group.

D. The department Safety Officer oversees and manages safety for the department as a whole. He is the liaison between the department, the EMS safety committee and EH&S and a resource for any safety-related questions

E. The Materials Safety Awareness Organization (MSAO) is the department safety committee, whose members include the Safety Officer and a faculty member, who are co-

chairs of the committee, in addition to other faculty, staff and students (including the chair and chair-elect of the LSM group).

F. 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 in any departmental labs (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, 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 necessary to consider the potential hazards and safety precautions involved in the work. Hazards may include toxic substances, hot surfaces, electrical circuits, mechanical equipment, and waste chemicals. Safety precautions should include correct materials storage, proper ventilation, proper grounding of equipment, hazard warning labels and training sessions when necessary. MatSE policy requires the preparation and posting of a Hazard Assessment Tool (HAT) form about the unique hazards and precautions necessary for any type of work, available at http://www.matse.psu.edu/safety/links-forms. Appropriate standard operating procedures (SOP) must also be available. Templates for writing SOPs can be found at http://www.ehs.psu.edu/laboratory-and-research-safety/laboratory-safety/forms and at http://www.ehs.ucsb.edu/labsafety-chp/sops). Additional SOP templates are available from many sources online. Safety Data Sheets (SDS) and equipment manuals are important sources of information. Prior to starting any experiments, an SDS, 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 (EHS) maintains a file of thousands of SDS sheets and is available to assist in obtaining them (865-6391). EH&S personnel are also available to review the project safety requirements and potential hazards with you. An example of a SDS 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 Research Unit A (RUA) and the Research Unit A Modular Laboratories (RUA Mod Labs). 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. 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 at 865-6391. The department 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 863-1111 or 911.

2. Be prepared to describe accurately the nature of the accident, the telephone number you are calling from, your name, any injuries and the existing hazards (such as fire, chemical fumes, leaking gas cylinder, exposed electrical wires).
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.

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 (as per Penn State Policy SY21, https://guru.psu.edu/policies/SY21.html)

A first aid kit shall be located in a clearly visible place in each laboratory. The contents of each first aid kit should be inventoried at least quarterly (every 3 months) and restocked in a timely fashion by laboratory personnel.

Appropriate supplies and equipment which may be purchased and maintained in University-funded first aid kits may include, but are not limited to:

Adhesive Bandages (Band-Aids)
Liquid bandage (individual use packets)
Bandage scissors
Blanket
Cotton
Gauze Pads (such as 4" x 4" or 3" x 3")
Ice Packs (chemical) (or use Ziploc bags if ice is available)
Medical Gloves (Nitrile preferred)
Medical Tape
Cleansing Towelettes (individual use packets)
Roller Gauze (recommended 1"-3")
Triangular Bandages
Elastic Bandages (Ace wrap)
Gauze Bandages (self-adhering)
CPR barrier*
Splints (when needed)*
Antibiotic ointment (individual use packets)
Burn treatment (individual use packets)
First Aid Cream (individual use packets)

** Only if personnel in the first aid kit area are CPR certified and/or are familiar with their use.*

2. Safety Showers and Eyewashes

Safety showers are located just inside each laboratory entrance and eyewash fountains at each laboratory sink in Steidle. Every laboratory worker should know these locations and how to operate the safety showers and eye wash fountains.

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), CPR is essential to keeping blood flowing to the victim's vital organs until professional help arrives. Do not waste time looking around for help, yell for help while performing CPR on the victim.

Training in Cardio-Pulmonary Resuscitation (CPR) is available through Health Matters in the James M. Elliott Building. Follow the Wellness Program link at http://ohr.psu.edu/health-matters/ to sign up for training.

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 (863-1111 or 911).
b. Raise the bleeding part higher than the rest of the body and continue to apply direct pressure.
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 person 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 863-1111 or 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 deliria.

V. GENERAL LABORATORY SAFETY RULES

See EHS Laboratory Safety Program at: http://www.ehs.psu.edu/laboratory-and-research-safety

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. Mandatory in all laboratories. 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 SDS.

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 they must be properly fitted. There are also a variety of cartridges available, each having a specific application. Cloth/paper respirators 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 EHS personnel.

Clothing. At a minimum, long pants and closes-toed shoes with solid uppers (e.g., no mesh or fabric) are required when working in a laboratory. Lab coats and safety glasses are also a must. In situations where splashing or spills may occur it is wise to protect your body with goggles and face shields and splash aprons, and gloves may be needed for chemicals that are corrosive or easily absorb through the skin. Glove materials must be chosen such that they are appropriate for handling the specific chemicals being used. Neither open-toed shoes or sandals nor shorts or skirts are allowed 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 EHS.

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 SDS should specify the glove type but if in doubt call EHS for assistance, or use the glove selection chart: http://www.ehs.psu.edu/hazardous-materials/chemical-safety/resources

General

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

Remove gloves and lab coats and 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 leaving the university, each researcher 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 difficult and costly to dispose of unlabeled chemicals.

Do not pipette 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. EHS 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 must 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 must not be carried in open containers in hallways or elevators where they may be spilled.

5. Chemical Storage

See EHS Chemical Compatibility Chart at: http://www.ehs.psu.edu/hazardous-materials/chemical-safety/resources

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 SDS before storing any chemical. The label or SDS 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 of chemicals

Never store 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. Even seemingly benign chemicals

can react violently under certain circumstances. Before using an unfamiliar chemical for the first time, consult the chemical's SDS sheet for incompatible chemical combinations. Additionally, lists of incompatible chemicals are available from EHS and on the internet. 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/Bases
- Oxidizers (including hydrogen peroxide)
- 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 at https://guru.psu.edu/policies/SY08.html

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 C for a list of chemicals that can form explosive peroxides.

Stability refers to the susceptibility of a chemical to dangerous decomposition. The label and SDS 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, date opened and discard date 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 C.

d. Shock Sensitive Chemicals

See Appendix C 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 SDS will indicate if a chemical is shock sensitive.

i. Wear appropriate personal protective equipment when handling shock sensitive chemicals.

ii. Write the date received, date opened and discard date 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 C

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.

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.

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 EHS 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. Not every mercury spill qualifies as an emergency, but all mercury spills have the potential for creating an unsafe environment. Contact EHS for all mercury spills. See http://www.ehs.psu.edu/case-emergency for more information regarding mercury spills.

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 EHS 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 EHS 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 are high energy sources and should always be treated as such. Read and post "Sleeping Giant" (found in Appendix C).

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 SDS 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 extremes.
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 Gas Cylinder Contents

Keep the following guidelines in mind during the withdrawal of gas from a 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 gas cylinders and auxiliary equipment be forced. If the threads do not match, return the cylinder to General Stores.
g. Teflon tape 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 EHS.
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. Gas Cylinder Leakage

Should a cylinder leak, the following actions 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 the above efforts fail, 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 (EHS) 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 6 m (20 feet), or separated by a fire resistant partition with a height no less than that of the cylinders.

6. Toxic Gas Restrictions

a. Before using a toxic gas, all label information and Safety Data Sheets (SDS) associated with the use of the particular poison gas shall be read
b. All plans and procedures involving toxic gas usage shall be reviewed and approved by EHS prior to beginning use of the gas.
c. If EHS determines that respiratory protection is required, respirator selection and training shall be done by EHS.
d. Toxic gases should only be used in force-ventilated areas, preferably in hoods with forced ventilation, or outdoors.
e. Toxic gas 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. Make sure that long hair is pulled back and loose clothing cannot get caught in moving parts.

5. Attach an "emergency shutdown procedure card" to any piece of equipment left operating unattended. 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.
6. Laboratory equipment is not to be placed in corridors.

E. Vacuum Systems

Mechanical vacuum pumps used in laboratories pose common hazards. There are the mechanical hazards associated with any moving parts and chemical hazards associated with 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 injury due to shards of containers generated by 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-generated container shards. 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 to prevent accidental disconnection or disconnection caused by high vapor pressure.

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 Equipment

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°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°C should be careful to guard against the possibility that water (or some other volatile substance) could fall into the hot bath. Such an event 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 must 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 of refrigerator is suitable for storing flammable liquids.
3. The explosion-**proof** refrigerator also has its control mounted on the outside but, in addition, the controls 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 beverages.

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, organic compounds decompose 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. Furnaces used for burn out must be vented. The CRC Handbook of Chemistry and Physics lists explosion limits for some substances. If in doubt contact EHS 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 following 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.
2. When work is being conducted within the hood, keep the sash at the recommended height. The maximum working height necessary to attain the proper inflow velocity is posted in your hood and updated annually by EHS.
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.
6. Sashes must be closed when not being accessed.

L. Housekeeping

Work areas shall be kept clean and free from obstructions. Cleanup 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 name of the person storing the chemicals. Chemicals stored in the laboratory should be inventoried annually and unneeded items disposed of. Containers should also be examined for deteriorating labels and lids. The quantity 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 safety manager should arrange for the removal or 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.

Chemical waste should be placed in appropriate receptacles and properly labeled. Broken glassware, pipettes, razor blades and syringes shall be placed in the appropriate glass disposal or sharps containers, respectively.

VI. CHEMICAL HAZARDS AND SAFETY PROCEDURES

The first step in using any chemical should be a review of the safety data sheet supplied by the manufacturer or obtained from the EHS 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. Remember that HAT forms must accompany ALL experiments, whether unattended or not.

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. Apply HF gel (such as calcium glucomate). Cover the exposed area with wet, iced cloths and get immediate medical help. 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, friction, or even 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 their 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 SDS of a solvent before using it to become aware of the hazards, safety precautions, and emergency procedures associated with that specific solvent. Always solvents 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. The 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, which is the 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°C). Combustible liquids have flash points between 100°F (37.7°C) and 210°F (93.3°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 cannot usually 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. Note that smoking is prohibited in all campus buildings.
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 EHS 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 EHS (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 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 EHS.

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 SDS for the chemical or by discussion with EHS 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 to seal these containers.
- Oxidizing agents should be used with caution in the vicinity of flammable materials.

H. Alkali Metals

Alkali metals react violently with water and cause decomposition of 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 EHS 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 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 SDS. 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 tests must be kept on file in the EHS 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. 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 must 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.edu/hazmat/index.cfm

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 works in a laboratory containing chemicals or 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. Ensure that the waste container material is compatible with the waste and that 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. All waste containers must have a properly filled out, red EHS tag attached to them.
d. Properly segregate the waste materials. Chemicals should be segregated into the following categories: Flammables, corrosives, poisons and oxidizers.
e. Properly store in designated secondary containment vessels.
f. Properly fill out the appropriate Chemical Manifest form online.

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. Anyone using equipment which generates any of these types of radiation must take and pass training specific to the hazard. See https://apps.opp.psu.edu/ehs_training/course_list.cfm?page_action=ViewCourses&category=8 to register for training. However, several precautionary procedures should always be followed:

A. Radioactive Materials (PSU Policy SY15, http://guru.psu.edu/policies/SY15.html)

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 EHS 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. Contact EHS to have such surveys performed.

8. Report any suspected overexposures to EHS 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 (PSU Policy SY17, https://guru.psu.edu/policies/SY17.html)

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

1. Users of lasers are required to complete the laser safety training provided by EHS before beginning work with lasers.

2. Never look directly at the beam or pump source.

3. 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.

4. Do not allow any object which could cause specular reflections in or along the beam. Examples are spherical buttons, screw heads, or jewelry.

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

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

7. 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 EHS 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, men 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 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 your 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 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 non-conducting 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 cool 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 applies 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 is 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 Guide to Classes of Fires in Section D below.

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. Convene near the E.E. West loading dock immediately following the evacuation. Roll call will be taken. Do not return to the building unless permitted to do so by Emergency Personnel.

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 EHS.

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., New York, 1978.

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

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

5. Prudent Practices for Disposal of Hazardous Chemicals from Laboratories, National Academy

6. Press, Washington, D.C., 1983.

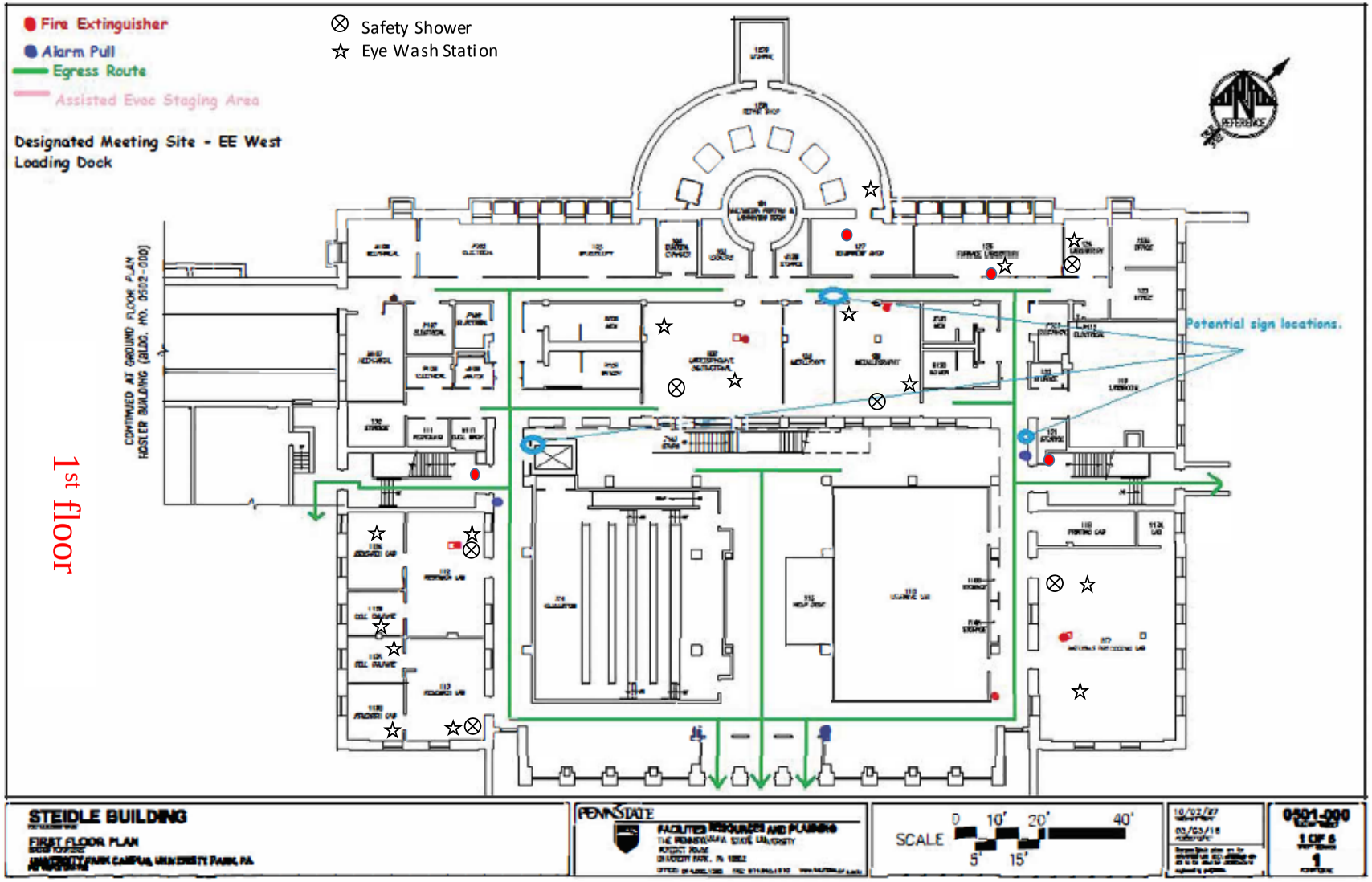
7. Occupational Health Guidelines for Chemical Hazards, NIOSH-OSHA, Jan., 1981.

8. 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 safety showers, fire extinguishers and eye wash fountains, in addition to evacuation routes

The plans below are draft versions pending final versions from EHS


Fire Extinguisher
Alarm Pull
Egress Route
Assisted Evac Staging Area
Designated Meeting Site - EE West Loading Dock
Safety Shower
Eye Wash Station
Potential sign locations.
1st floor
STEIDLE BUILDING
FIRST FLOOR PLAN
PENNSTATE
FACILITIES RESOURCES AND PLANNING
SCALE
0
10'
20'
40'
5'
15'
0501-000
1 OF 6
1

Fire Extinguisher

Alarm Pull

Egress Route

Assisted Evac Staging Area

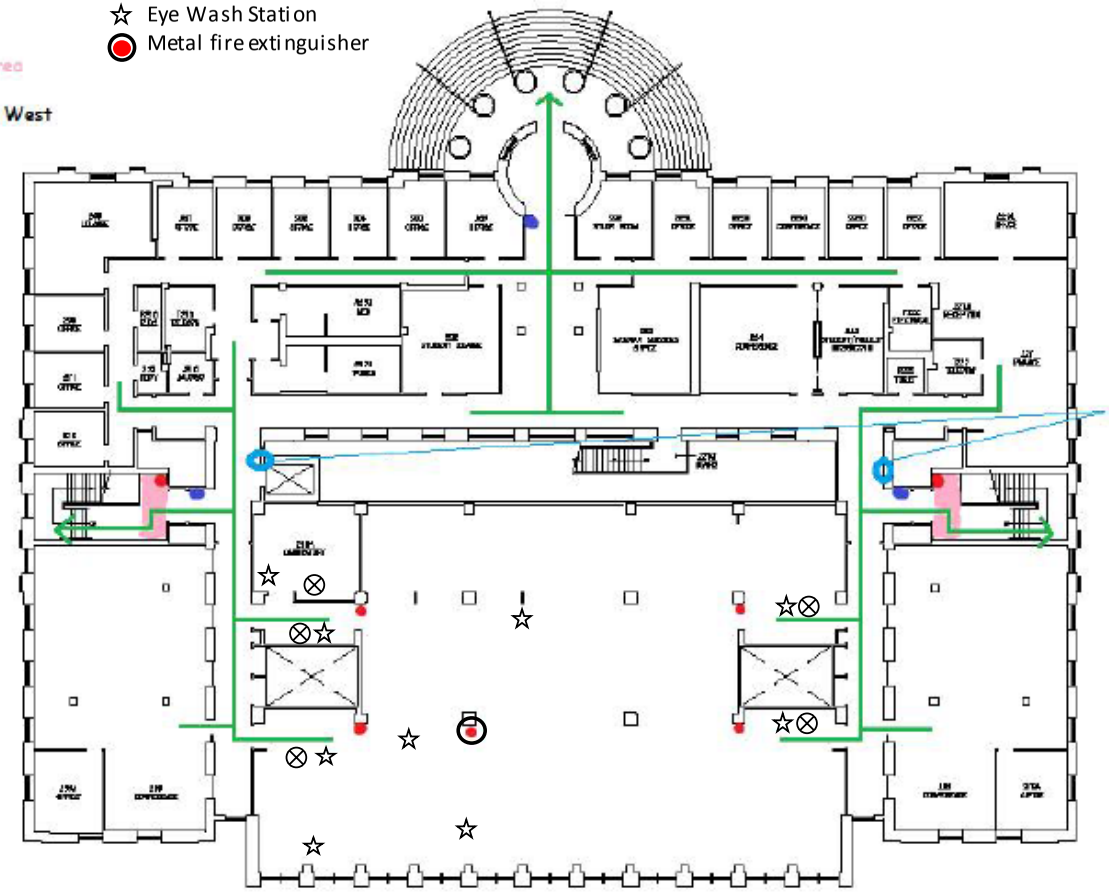
Designated Meeting Site - EE West

Loading Dock

Safety Shower

Eye Wash Station

Metal fire extinguisher



2nd floor

STEIDLE BUILDING

SECOND FLOOR PLAN

UNIVERSITY PARK CAMPUS, UNIVERSITY PARK, PA

PENNSTATE

FACILITIES RESOURCES AND PLANNING

THE PENNSYLVANIA STATE UNIVERSITY

SCALE 0 10' 20' 40' / 5' 15'

01/00/15

0301-000

2 OF 8

2

Fire Extinguisher

Alarm Pull

Egress Route

Assisted Evac Staging Area

Designated Meeting Site - EE West Loading Dock

Safety Shower

Eye Wash Station

Metal Fire Extinguisher

3rd floor

STEIDLE BUILDING

THIRD FLOOR PLAN

UNIVERSITY PARK CAMPUS, UNIVERSITY PARK, PA

PENNSTATE

FACILITIES RESOURCES AND PLANNING

THE PENNSYLVANIA STATE UNIVERSITY

SCALE 0 10' 20' 40' 5' 15'

0401-000

3 OF 8

3

Fire Extinguisher

Alarm Pull

Egress Route

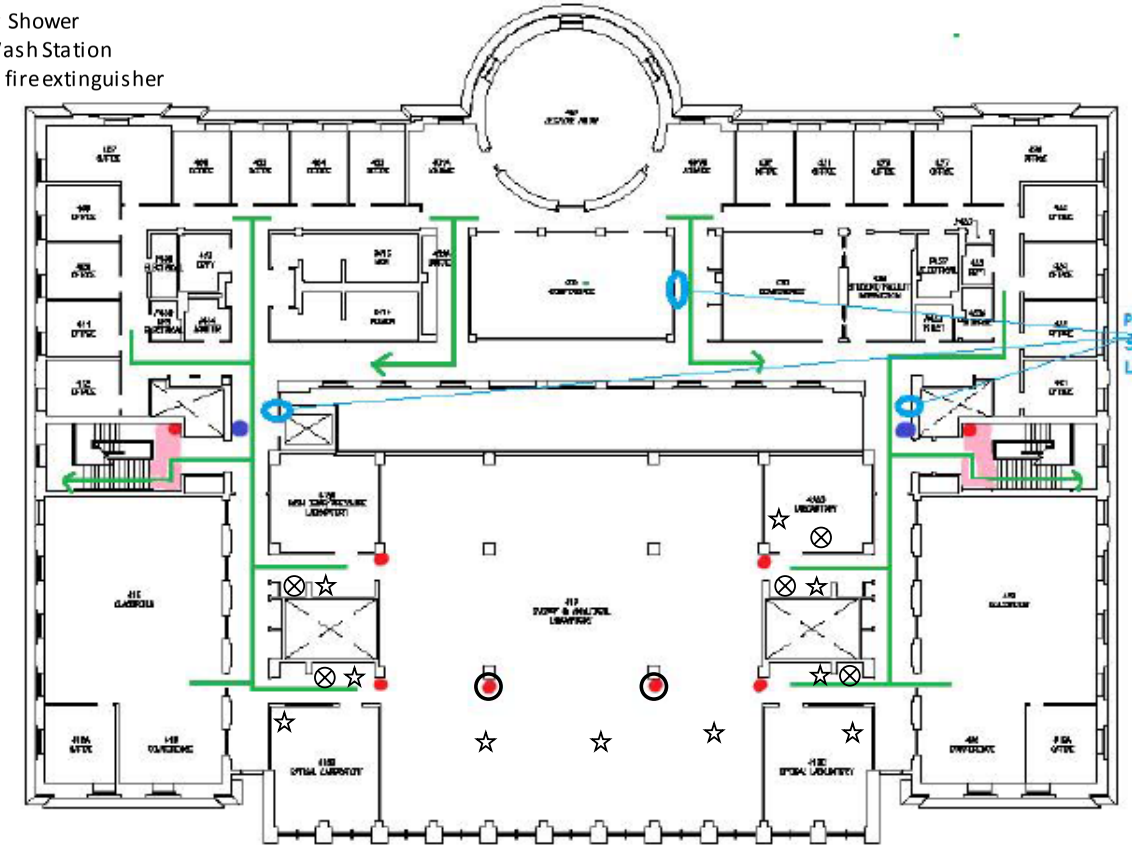
Assisted Evac Staging Area

Designated Meeting Site - EE West Loading Dock

Safety Shower

Eye Wash Station

Metal fire extinguisher



4th floor

STEIDLE BUILDING

FOURTH FLOOR PLAN

UNIVERSITY PARK CAMPUS, UNIVERSITY PARK, PA

PENNSTATE

FACILITIES RESOURCES AND PLANNING

THE PENNSYLVANIA STATE UNIVERSITY

SCALE 0 10' 20' 40' 5' 15'

0-101-000

4 OF 8

4

APPENDIX B

Example Material Safety Data Sheets (SDS) for acetone and aluminum oxide

SAFETY DATA SHEET

Creation Date 28-Apr-2009 **Revision Date** 12-Mar-2014 **Revision Number** 1

1. Identification

Product Name **Acetone**

Cat No. : **AC177170000; AC177170010; AC177170025; AC177170050; AC177170100; AC177170250**

Synonyms 2-Propanone

Recommended Use Laboratory chemicals.

Uses advised against No Information available

Details of the supplier of the safety data sheet

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Entity / Business Name
Acros Organics
One Reagent Lane
Fair Lawn, NJ 07410

Emergency Telephone Number
For information **US** call: 001-800-ACROS-01 / **Europe** call: +32 14 57 52 11
Emergency Number **US:**001-201-796-7100 / **Europe:** +32 14 57 52 99
CHEMTREC Tel. No.**US:**001-800-424-9300 / **Europe:**001-703-527-3887

2. Hazard(s) identification

Classification
This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Flammable liquids	Category 2
Serious Eye Damage/Eye Irritation	Category 2
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Central nervous system (CNS).	
Specific target organ toxicity - (repeated exposure)	Category 2
Target Organs - Kidney, Liver, spleen, Blood.	

Label Elements

Signal Word
Danger

Hazard Statements
Highly flammable liquid and vapor
Causes serious eye irritation
May cause drowsiness or dizziness
May cause damage to organs through prolonged or repeated exposure

Precautionary Statements
Prevention
Wash face, hands and any exposed skin thoroughly after handling
Do not breathe dust/fume/gas/mist/vapors/spray
Use only outdoors or in a well-ventilated area
Keep away from heat/sparks/open flames/hot surfaces. - No smoking
Keep container tightly closed
Ground/bond container and receiving equipment
Use explosion-proof electrical/ventilating/lighting/equipment
Use only non-sparking tools
Take precautionary measures against static discharge
Wear protective gloves/protective clothing/eye protection/face protection
Keep cool
Response
Get medical attention/advice if you feel unwell
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Call a POISON CENTER or doctor/physician if you feel unwell
Skin
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
Eyes
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
If eye irritation persists: Get medical advice/attention
Fire
In case of fire: Use CO2, dry chemical, or foam for extinction
Storage
Store in a well-ventilated place. Keep container tightly closed
Store locked up
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
Repeated exposure may cause skin dryness or cracking

3. Composition / information on ingredients

Component	CAS-No	Weight %
Acetone	67-64-1	>95

4. First-aid measures

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Obtain medical attention.

Skin Contact Wash off immediately with plenty of water for at least 15 minutes. Obtain medical attention.

Inhalation Move to fresh air. If breathing is difficult, give oxygen. Get medical attention immediately if symptoms occur.

Ingestion Do not induce vomiting. Obtain medical attention.

Most important symptoms/effects Breathing difficulties. Symptoms of overexposure may be headache, dizziness, tiredness, nausea and vomiting: May cause pulmonary edema: Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting

Notes to Physician Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media CO_2, dry chemical, dry sand, alcohol-resistant foam. Water spray. Cool closed containers exposed to fire with water spray.

Unsuitable Extinguishing Media Water may be ineffective

Flash Point -20 °C / -4 °F
Method - Closed cup

Autoignition Temperature 465 °C / 869 °F

Explosion Limits
Upper 12.8 vol %
Lower 2.5 vol %

Oxidizing Properties Not oxidising

Sensitivity to Mechanical Impact No information available
Sensitivity to Static Discharge No information available

Specific Hazards Arising from the Chemical
Flammable. Risk of ignition. Containers may explode when heated. Vapors may form explosive mixtures with air. Vapors may travel to source of ignition and flash back.

Hazardous Combustion Products
Carbon monoxide (CO) Carbon dioxide (CO_2) Formaldehyde Methanol
Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

NFPA

Health	Flammability	Instability	Physical hazards
1	3	0	N/A

6. Accidental release measures

Personal Precautions Use personal protective equipment. Ensure adequate ventilation. Remove all sources of ignition. Take precautionary measures against static discharges. Keep people away from and upwind of spill/leak. Avoid contact with skin, eyes and inhalation of vapors.

Environmental Precautions Should not be released into the environment.

Methods for Containment and Clean Up Remove all sources of ignition. Take precautionary measures against static discharges. Soak up with inert absorbent material. Keep in suitable, closed containers for disposal. Use spark-proof tools and explosion-proof equipment.

7. Handling and storage

Handling Wear personal protective equipment. Ensure adequate ventilation. Keep away from open flames, hot surfaces and sources of ignition. Take precautionary measures against static discharges. Use only non-sparking tools. Use explosion-proof equipment. Do not breathe vapors or spray mist. Do not get in eyes, on skin, or on clothing. To avoid ignition of vapors by static electricity discharge, all metal parts of the equipment must be grounded.

Storage Flammables area. Keep containers tightly closed in a dry, cool and well-ventilated place. Keep away from heat and sources of ignition. Keep container tightly closed in a dry and well-ventilated place.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH
Acetone	TWA: 500 ppm STEL: 750 ppm	(Vacated) TWA: 750 ppm (Vacated) TWA: 1800 mg/m³ (Vacated) STEL: 2400 mg/m³ (Vacated) STEL: 1000 ppm TWA: 1000 ppm TWA: 2400 mg/m³	IDLH: 2500 ppm TWA: 250 ppm TWA: 590 mg/m³

Component	Quebec	Mexico OEL (TWA)	Ontario TWAEV
Acetone	TWA: 500 ppm TWA: 1190 mg/m³ STEL: 1000 ppm STEL: 2380 mg/m³	TWA: 1000 ppm TWA: 2400 mg/m³ STEL: 1260 ppm STEL: 3000 mg/m³	TWA: 500 ppm STEL: 750 ppm

Legend

ACGIH - American Conference of Governmental Industrial Hygienists
OSHA - Occupational Safety and Health Administration
NIOSH IDLH: The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health

Engineering Measures Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location. Use explosion-proof electrical/ventilating/lighting/equipment.

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection Wear appropriate protective gloves and clothing to prevent skin exposure.

Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Hygiene Measures Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Colorless
Odor	sweet
Odor Threshold	19.8 ppm
pH	7
Melting Point/Range	-95 °C / -139 °F
Boiling Point/Range	56 °C / 132.8 °F
Flash Point	-20 °C / -4 °F
Method -	Closed cup
Evaporation Rate	5.6 (Butyl Acetate = 1.0)
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	12.8 vol %
Lower	2.5 vol %
Vapor Pressure	247 mbar @ 20 °C
Vapor Density	2.0
Relative Density	0.790
Solubility	Soluble in water
Partition coefficient; n-octanol/water	No data available

Autoignition Temperature	465 °C / 869 °F
Decomposition Temperature	> 4°C
Viscosity	0.32 mPa.s @ 20 °C
Molecular Formula	C3 H6 O
Molecular Weight	58.08
Refractive index	1.358 - 1.359

10. Stability and reactivity

Reactive Hazard None known, based on information available

Stability Stable under normal conditions.

Conditions to Avoid Heat, flames and sparks. Incompatible products. Keep away from open flames, hot surfaces and sources of ignition.

Incompatible Materials Strong oxidizing agents, Strong reducing agents, Strong bases, Peroxides, Halogenated compounds, Alkali metals, Amines

Hazardous Decomposition Products Carbon monoxide (CO), Carbon dioxide (CO_2), Formaldehyde, Methanol

Hazardous Polymerization Hazardous polymerization does not occur.

Hazardous Reactions None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Acetone	5800 mg/kg (Rat)	> 15800 mg/kg (rabbit) > 7400 mg/kg (rat)	76 mg/l, 4 h, (rat)

Toxicologically Synergistic Products Carbon tetrachloride; Chloroform; Trichloroethylene; Bromodichloromethane; Dibromochloromethane; N-nitrosodimethylamine; 1,1,2-Trichloroethane; Styrene; Acetonitrile, 2,5-Hexanedione; Ethanol; 1,2-Dichlorobenzene

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation Irritating to eyes and skin

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Acetone	67-64-1	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects No information available

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

STOT - single exposure Central nervous system (CNS)

STOT - repeated exposure Kidney Liver spleen Blood

Aspiration hazard No information available

Symptoms / effects,both acute and Symptoms of overexposure may be headache, dizziness, tiredness, nausea and vomiting:

delayed May cause pulmonary edema: Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting

Endocrine Disruptor Information No information available

Other Adverse Effects Neurotoxic effects have occurred in experimental animals.

12. Ecological information

Ecotoxicity

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Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Acetone	NOEC = 430 mg/l (algae; 96 h)	Oncorhynchus mykiss: LC50 = 5540 mg/l 96h Alburnus alburnus: LC50 = 11000 mg/l 96h Leuciscus idus: LC50 = 11300 mg/L/48h Salmo gairdneri: LC50 = 6100 mg/L/24h	EC50 = 14500 mg/L/15 min	EC50 = 8800 mg/L/48h EC50 = 12700 mg/L/48h EC50 = 12600 mg/L/48h

Persistence and Degradability Persistence is unlikely based on information available.

Bioaccumulation/ Accumulation No information available.

Mobility Will likely be mobile in the environment due to its volatility.

Component	log Pow
Acetone	-0.24

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

Component	RCRA - U Series Wastes	RCRA - P Series Wastes
Acetone - 67-64-1	U002	-

14. Transport information

DOT

- **UN-No** UN1090
- **Proper Shipping Name** ACETONE
- **Hazard Class** 3
- **Packing Group** II

TDG

- **UN-No** UN1090
- **Proper Shipping Name** ACETONE
- **Hazard Class** 3
- **Packing Group** II

IATA

- **UN-No** UN1090
- **Proper Shipping Name** ACETONE
- **Hazard Class** 3
- **Packing Group** II

IMDG/IMO

- **UN-No** UN1090
- **Proper Shipping Name** ACETONE
- **Hazard Class** 3
- **Packing Group** II

15. Regulatory information

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
Acetone	X	X	-	200-662-2	-		X	X	X	X	X

Legend:
X - Listed
E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.
F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.
N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
P - Indicates a commenced PMN substance
R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.
S - Indicates a substance that is identified in a proposed or final Significant New Use Rule
T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).
Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313 Not applicable

SARA 311/312 Hazardous Categorization

Acute Health Hazard	Yes
Chronic Health Hazard	Yes
Fire Hazard	Yes
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

Clean Water Act Not applicable

Clean Air Act Not applicable

OSHA Occupational Safety and Health Administration
Not applicable

CERCLA
This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Acetone	5000 lb	-

California Proposition 65 This product does not contain any Proposition 65 chemicals

State Right-to-Know

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Acetone	X	X	X	-	X

U.S. Department of Transportation

Reportable Quantity (RQ):	Y
DOT Marine Pollutant	N
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security
This product contains the following DHS chemicals:

Component	DHS Chemical Facility Anti-Terrorism Standard
Acetone	2000 lb STQ

Other International Regulations

Mexico - Grade Serious risk, Grade 3

Canada
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR

WHMIS Hazard Class B2 Flammable liquid
D2B Toxic materials

16. Other information

Prepared By Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Creation Date 28-Apr-2009
Revision Date 12-Mar-2014
Print Date 12-Mar-2014
Revision Summary This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS)

Disclaimer
The information provided on this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guide for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered as a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other material or in any process, unless specified in the text.

End of SDS

SAFETY DATA SHEET

Issuing Date 06-Feb-2012 **Revision Date** 15-Feb-2016 **Revision Number** 19

1. IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

1.1. Product identifier

Product Code 387

Product Name **CALCINED ALUMINA and POLISHING ALUMINA**

Contains Aluminum oxide, CAS 1344-28-1

Synonyms A-Aluminas, AB-Aluminas, CL-Aluminas, CT-Aluminas, CTC-Aluminas, E-SY 1000, Flux Grade, Fusion Grade, Gilox, HVA, IS-Aluminas, LS-Aluminas, P-Aluminas, RG-Aluminas, Refractory Grade, SC-Aluminas, Special Grade, WRA, Exception: CTC55 - see Material Safety Data Sheet 1000, Exception: CT3000 SDP - see Material Safety Data Sheet 1259

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use
Adsorbents, Ceramic, Filler, Polishing agent, Refractory

Uses advised against
No information available

1.3. Details of the supplier of the safety data sheet

Almatis GmbH
Lyoner Str. 9
60528 Frankfurt
Germany

Almatis GmbH
Giulinistrasse 2
67065 Ludwigshafen
Germany

Almatis, Inc.
P.O. Box 300
4701 Alcoa Road
Bauxite, AR 72022 USA

Almatis, Inc.
501 West Park Road
Leetsdale, PA 15056 USA

Almatis Alumina Pvt. Ltd.
Falta Industrial Growth Centre,
Sec III
24-Parganas South, West
Bengal
Falta, India

Qingdao Almatis Co., Ltd.
Box 150, Sunshine Tower
61 Hongkong Middle Road
Qingdao 266071
P.R. China

Almatis Burnside, Inc.
41237 Hwy 22
Burnside, LA 70738, USA

For further information, please contact
info@almatis.com

1.4. Emergency telephone number

Almatis: +1 501-776-4677

CHEMTREC:
+1-703-527-3887 (INTERNATIONAL)
+1-800-424-9300 (NORTH AMERICA)

2. HAZARDS IDENTIFICATION

2.1. - Classification of the substance or mixture

REGULATION (EC) No 1272/2008
The product is not classified as dangerous according to Regulation (EC) No. 1272/2008

Classification according to Directive 67/548/EEC or 1999/45/EC
Not classified

GHS Classification
The product is not classified as hazardous according to GHS

2.2. Label Elements

Symbol(s)
Not applicable

Signal Word
None

Hazard Statements
None

Precautionary Statements
P261 - Avoid breathing dust/fume/gas/mist/vapors/spray
P280 - Wear eye protection/ face protection
P285 - In case of inadequate ventilation wear respiratory protection
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P302 + P352 - IF ON SKIN: Wash with plenty of soap and water

2.3. Other information
No information available

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1. Substances

Chemical Name	CAS No.	Weight-%	REACH Reg. No
Aluminum oxide	1344-28-1	>99	01-2119529248-35-0024 01-2119529248-35-0125 01-2119529248-35-0086 01-2119529248-35-0238

4. FIRST AID MEASURES

4.1. Description of first aid measures

Eye Contact IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing

Skin Contact Wash skin with soap and water.

Ingestion Rinse mouth

Inhalation Remove to fresh air

General Advice If symptoms persist, call a physician
Show this safety data sheet to the doctor in attendance

4.2. Most important symptoms and effects, both acute and delayed
No information available

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician
Treat symptomatically

5. FIRE-FIGHTING MEASURES

5.1. Extinguishing media

Suitable Extinguishing Media
The product itself does not burn
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment

Extinguishing media which must not be used for safety reasons
No information available

5.2. Special hazards arising from the substance or mixture
Special exposure hazards arising from the substance or preparation itself, combustion products, resulting gases
None in particular.

5.3. Advice for firefighters
Special protective equipment for fire-fighters
As in any fire, wear self-contained breathing apparatus and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

6.1. Personal precautions, protective equipment and emergency procedures
Wear personal protective equipment
Avoid dust formation

6.2. Environmental precautions
No special environmental precautions required

6.3. Methods and material for containment and cleaning up
Recover product. Place into appropriate container for disposal.

Methods for Cleaning Up
Shovel or sweep up

7. HANDLING AND STORAGE

7.1. Precautions for Safe Handling
Handling
Provide appropriate exhaust ventilation at places where dust is formed

General Hygiene Considerations
Handle in accordance with good industrial hygiene and safety practice

Exposure scenario
No information available

7.2. Conditions for safe storage, including any incompatibilities
Keep in a dry place

7.3. Specific end use(s)
No information available

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Control parameters

Chemical Name	EU	United Kingdom	France	Spain	Germany OEL (TWA)
Aluminum oxide 1344-28-1			VME: 10 mg/m^3	VLA-ED: 10 mg/m^3	1.25 mg/m^3 6.0 mg/m^3(a)

(a) GOEL - Germany - TRGS 900 - Occupational Exposure Limits - TWAs, (a) exempt facilities listed in 2.4(8) and (9)

Component	Italy	Portugal	Netherlands	Finland	Denmark
Aluminum oxide 1344-28-1 (>99)		TWA: 10 mg/m^3			TWA: 10 mg/m^3

Component	OSHA PEL	ACGIH TWA
Aluminum oxide	15 mg/m^3 TWA (total dust); 5 mg/m^3	1 mg/m^3 TWA (respirable fraction)

1344-28-1 (>99)	TWA (respirable fraction)	

Derived No Effect Level (DNEL) 3 mg/m³, respirable, 8 hour TWA

Predicted No Effect Concentration (PNEC) No information available

8.2. Exposure controls

Engineering Controls Ensure adequate ventilation, especially in confined areas

Personal protective equipment

Eye Protection Safety glasses with side-shields

Skin Protection No special protective equipment required.

Hand Protection No special protective equipment required.

Respiratory Protection When workers are facing concentrations above the exposure limit they must use appropriate certified respirators

Environmental exposure controls Avoid dust formation

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1. Information on basic physical and chemical properties

Physical State	Powder, Granular
Color	White
Odor	None
pH	8 - 10
Flash point (°C) DEGREES	Not applicable
Boiling point/range (°C) DEGREES	2210
Melting point (°C) DEGREES	2000 – 2050
Solubility	Insoluble
Density	2.7-3.94 g/cm3
Bulk Density	350-1250 kg/m³

10. STABILITY AND REACTIVITY

10.1. Reactivity

None under normal processing

10.2. Chemical Stability

Stable under normal conditions

10.3. Possibility of Hazardous Reactions

None under normal processing

10.4. Conditions to Avoid

None under normal processing

10.5. Incompatible materials

None under normal processing

10.6. Hazardous Decomposition Products

None under normal processing

11. TOXICOLOGICAL INFORMATION

11.1. Information on toxicological effects

Acute Toxicity

Acute oral toxicity	Conclusive but not sufficient for classification
Acute dermal toxicity	Conclusive but not sufficient for classification
Acute inhalation toxicity	Conclusive but not sufficient for classification

Chronic Toxicity

Irritation	Conclusive but not sufficient for classification
Corrosivity	Conclusive but not sufficient for classification
Sensitization	Conclusive but not sufficient for classification
Mutagenic Effects	Conclusive but not sufficient for classification
Carcinogenic effects	Conclusive but not sufficient for classification
Reproductive Effects	Conclusive but not sufficient for classification
Developmental Effects	Conclusive but not sufficient for classification
Aspiration Hazard	Conclusive but not sufficient for classification

12. ECOLOGICAL INFORMATION

12.1. Toxicity

Ecotoxicity effects

Not water endangering

Aquatic toxicity is unlikely due to low solubility

12.2. Persistence and degradability

No information available

12.3. Bioaccumulative potential.

No information available

12.4. Mobility in soil

No information available

12.5. Results of PBT and vPvB assessment

No information available

12.6. Other adverse effects

None known

13. DISPOSAL CONSIDERATIONS

13.1. Waste treatment methods

Waste from Residues/Unused Products

Disposal should be in accordance with applicable regional, national and local laws and regulations

Contaminated Packaging

Empty containers should be taken to an approved waste handling site for recycling or disposal

14. TRANSPORT INFORMATION

Note: Not classified as dangerous in the meaning of transport regulations

IMDG/IMO Not regulated.

RID RID Not regulated.

ADR Not regulated Not regulated.

ICAO Not regulated Not regulated.

IATA Not regulated Not regulated.

15. REGULATORY INFORMATION

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

International Inventories

TSCA	Complies
EINECS/ELINCS	Complies
DSL/NDSL	Listed on DSL
PICCS	Complies
ENCS	Complies
IECSC	Complies
AICS	Complies
KECL	Complies

Legend
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
PICCS - Philippines Inventory of Chemicals and Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
AICS - Australian Inventory of Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances

15.2. Chemical Safety Assessment
A Chemical Safety Assessment has been carried out

16. OTHER INFORMATION

Key literature references and sources for data
www.ChemADVISOR.com/

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Revision Summary
Revision 11, April 2008
Section 1, changed contact address
Section 16, added email address and revision history
Revision 12, June 2010
Section 1, added additional products to synonyms
Revison 13, March 2011
Update to format
Revision 14, February 2012
Section 1, added Qingdao Almatis Ltd. to supplier details
Revision 15, July 2013
Section 15, corrected listing for DSL, ENCS, and PICCS
Revision 16, January 2014
Section 1, added AB-Aluminas
Section 1, added Almatis Burnside Inc..
Section 8, revised ACGIH TWA
Section 9, added boiling point and revised melting point
Revision 17, August 2014
Section 8, revised GOEL
Revision 18, February 2015
Section 1, added Polishing Alumina to product name
Section 1, revised synonyms
Revision 19, February 2016
Section 1, added Fusion, Refractory, and Special Grades

Updates
The most current version of this Safety Data Sheet is available at this URL:
http://almatiswv.thewercs.com/private/search.aspx?language=EN

This safety data sheet complies with the requirements of Regulation (EC) No. 1907/2006

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End of Safety Data Sheet

APPENDIX C

Shock Sensitive Chemicals
and
Explosive Peroxides
and
A Sleeping Giant

Shock Sensitive Chemicals

The following materials are shock-sensitive, and may decompose violently if struck or heated. Solids are also prone to explosive decomposition if ground, for example with pestle and mortar. A few of the materials listed are not, of themselves, explosive, but mixtures of them with combustible material such as organic reagents, may be dangerous.

The table provides examples of peroxide-forming and/or shock sensitive chemicals only and is not an inclusive list. Consult Material Safety Data Sheets for information on the peroxide-forming potential and shock sensitivity of specific chemicals.

- acetaldehyde
- ammonal
- ammonium picrate
- butyl tetryl
- cumene
- cyclohexane
- diethyl Ether
- dinitroglycerine
- dinitrophenyl hydrazine
- dipcrylamine
- ethylene glycol dimethyl
- ethyl vinyl eter
- fulmanating platinum
- guanyl nitrosamino
- guanylidene
- heavy metal azide
- hexanitrostilbene
- isopropyl ether
- lead mononitroresorcinate
- lead styphnate
- mannitol hexanitrate
- mercury oxalate
- nitrated carbohydrate
- nitrogen triiodide
- nitroglycide
- nitromethane
- nitrotoluene
- organic peroxides
- picramic acid
- polynitro aliphatic compounds
- potassium perchlorate
- silver azide
- silver tetrazene
- sodium perchlorate
- syphnic acid
- tetranitrocarbazole
- triethylene glucol divinyl ether
- trinit
- trinitrobenzene
- trinitro-meta-cresol
- trinitrophloroglucinol
- urea nitrate
- aluminun ophorite explosive
- ammonium nitrate
- benzoyl peroxide
- calcium nitrate
- cyanuric triazide
- cyclotrimethylenetrinitramine
- dinitroresorcinol
- dinitrophenol
- dinitrotoluene
- dipicryl sulfone
- ether
- fulminating mercury
- fulminating silver
- guanyltetrazene
- hydrazine
- hexanite

- hexogen
- lead azide
- ead picrate
- magnesium ophorite
- mercury oxalate
- mercury tartrate
- nitrated glucoside
- nitrogen trichloride
- nitroglycol
- nitronium perchlorate
- nitrourea
- organic nitramines
- picramide
- picryl chloride
- potassium metal
- robenzoic acid
- silver fulminate
- sodatol
- sodium dinitro-ortho-cresolate
- sodium picramate
- tert-butyl hydroperoxide
- tetraze
- trimethylolethane
- trinitroresorcinol
- trinitrobenzoic aci
- trinitronaphthalene
- trinitrotoluene (TNT)
- vinyl chloride
- amatol
- ammonium perchlorate
- 2-Butanol
- copper acetylide
- cyanogen Bromide
- dicyclopentadiene
- dinitroethyleneurea
- dinitrophenolates
- dioxane
- erythritol tetranitrate
- ethyl ether
- fulminating gold
- gelatinized nitrocellulose
- guanyl nitrosamino
- hydrazoic acid
- hexanitrodiphenylamine
- hyrazinium nitrate
- lead mannite
- lead salts
- magnesium perchlorate
- mercury fulminate
- mononitrotoluene
- nitrated polyhydric alcohol
- nitroglycerin
- nitroguanidine
- nitroparaffins
- organic amine nitrates
- perchloric acid
- picratol
- picryl fluoride
- potassium nitroaminotetrazole
- silver acetylide
- silver styphnate
- sodium amatol sodium nitrate/potassium nitrate (Mixture)
- styrene
- tetrahydrofuran (THF)
- tetrytol
- trimonite
- trinitroanisole
- trinitrocresol
- trinitrophenetol
- urea ammonium nitrate
- vinylidene chloride acetylides

Shock sensitive materials should be kept to a minimum by maintaining proper inventory consistent with the rate of use. Inventory is also important in order to dispose of chemicals which tend to form unstable materials with age, such as ethers, or materials which become dangerous when they become dehydrated, such as picric acids. Shock-sensitive materials should be stored in a cool, dry area, and protected from heat and shock. During storage, the materials should be segregated from incompatible materials including flammables and corrosives. Materials which are used specifically because of their explosive properties should be treated as an explosive of the appropriate class and kept in a explosive proof locker or the equivalent storage area.

http://www.ecu.edu/cs-admin/oehs/envmgmnt/Shock-sensitive.cfm

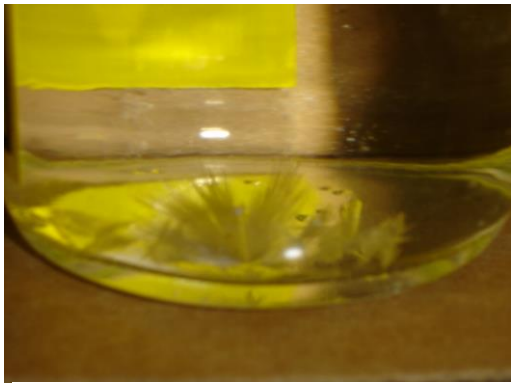
Peroxide-Forming Chemicals

Overview

Peroxide-forming chemicals are a class of compounds that have the ability to form shock-sensitive explosive peroxide crystals. Many of the organic solvents commonly used in Weill Cornell Medicine's (WCM's) laboratories have the potential to form explosive peroxide crystals. Diethyl ether and tetrahydrofuran are two of the more common peroxide-forming chemicals used at WCM. Therefore, it is extremely important that this procedure be followed regarding the identification, handling, storage, and disposal of peroxide-forming chemicals.

Under normal storage conditions, the materials listed in this document have the potential to generate and accumulate peroxide crystal formations, which may violently detonate when subjected to thermal or mechanical shock. Peroxide-forming chemicals react with oxygen—even at low concentrations to form peroxy compounds. The risk associated with peroxide formation increases if the peroxide crystallizes or becomes concentrated by evaporation or distillation. Factors that affect rate of peroxide formation include exposure to air, light and heat, moisture, and contamination from metals.

Peroxide crystals may form on the container plug or the threads of the lid and detonate when the lid is twisted. Do not open a liquid organic peroxide or peroxide-forming chemical if crystals or a precipitate are present.



Peroxide Formation

Applicability

This Update applies to all WCM personnel who are involved with the ordering, storage, or use of laboratory chemicals/reagents.

Definitions

A peroxide is a chemical that contains a peroxo (O-O) unit, one that has the chemical formula of $O2^{2-}$.

Responsibilities

Environmental Health and Safety (EHS) provides technical assistance lab personnel about the safe handling, storage and disposal of peroxide-forming chemicals and training as needed.

Lab personnel ensure that peroxide-forming chemicals are properly managed and disposed in accordance with this Update.

Procedure

1. **Purchasing Considerations**
   - When possible, purchase only peroxide-forming chemicals which contain a peroxide formation inhibitor (e.g., tetrahydrofuran or diethyl ether inhibited with butylated hydroxytoluene (BHT)).
   - Only purchase quantities of peroxide-forming chemicals that you expect to use within expiration and disposal timeframes.
2. **Labeling Requirements**
   - All bottles of peroxide-forming chemicals must have the date received marked on the container.
   - When the bottle is first opened, the container must be marked with the date opened.
   - Example Label:

Peroxide-Forming Chemical
Date Received:_____
Date Opened:_____

3. **Storage and Use Requirements**
   - Do not store peroxide-forming chemicals in direct sunlight, as light can accelerate the chemical reactions that form peroxides.
   - If the peroxide-forming chemical is flammable and requires refrigeration, an explosion-proof refrigerator must be used.
   - Do not distill, evaporate or concentrate a peroxide-forming chemical until you have first tested it for the presence of peroxides (peroxides are usually less volatile than their parent material and will tend to concentrate in the hot distillation pot).
   - **NEVER, UNDER ANY CIRCUMSTANCES**, touch or attempt to open a container of a peroxide-forming liquid if there are whitish crystals around the cap and/or in the bottle. The friction of screwing the cap may detonate the bottle. If you encounter such a bottle, contact EHS (646-962-7233) immediately for removal. **DO NOT TOUCH OR MOVE THE SUSPECT BOTTLE YOURSELF FOR ANY REASON.**
4. **Disposal Requirements**
   - There are four classes of peroxide-forming chemicals based upon the peroxide formation hazard:
     - Class A – Severe Peroxide Hazard
     - Class B – Concentration Hazard
     - Class C – Shock and Heat Sensitive
     - Class D – Potential Peroxide-Forming Chemicals
   - Peroxide-forming chemicals must be disposed within the timeframes specified in the following table, regardless of whether or not the container has been opened. Disposal with EHS must occur within the timeframe allowed once the container is received or opened, whichever is earlier.

	Class A	Class B	Class C	Class D
Date Opened	3 months	6 months	6 months	Only if peroxide crystals are present.
Date Received	1 year	1 year	1 year	

   - Submit an online Chemical Collection Request Form to EHS to request the disposal of a peroxide-forming chemical.
     - **NOTE**: If the peroxide-forming chemical has a visible peroxide formation or is greater than a year old, bypass the online form and contact EHS immediately. ***Do not move or handle these containers.***
   - EHS has contractors available to test and, if necessary, stabilize peroxide-forming chemicals.

Peroxide Forming Chemical Lists

CLASS A – SEVERE PEROXIDE HAZARD

Spontaneously decompose and become explosive with exposure to air without concentration.

- Butadiene (liquid monomer)
- Chloroprene (liquid monomer)
- Divinyl acetylene
- Isopropyl ether
- Potassium amide
- Potassium metal
- Sodium amide (sodamide)
- Tetrafluoroethylene (liquid monomer)
- Vinylidene chloride

CLASS B – CONCENTRATION HAZARD

Require external energy for spontaneous decomposition. Form explosive peroxides when distilled, evaporated or otherwise concentrated.

- Acetal
- Acetaldehyde
- Benzyl alcohol
- 2-Butanol
- Cumene
- Cyclohexanol
- Cyclohexene
- Diethylene glycol dimethyl ether (diglyme)
- Diethyl ether
- Dioxanes
- Ethylene glycol dimethyl ether (glyme)
- Furan
- 4-Heptanol
- 2-Hexanol
- 4-Methyl-2-pentanol
- 2-Pentanol
- 4-Penten-1-ol
- 1-Phenylethanol
- 2-Phenylethanol
- Tetrahydrofuran
- Tetrahydronaphthalene

- 2-Cyclohexen-1-ol
- Decahydronaphthalene
- Diacetylene
- Dicyclopentadiene
- Methylacetylene
- 3-Methyl-1-butanol
- Methylcyclopentane
- Methyl isobutyl ketone
- Vinyl ethers
- Other secondary alcohols

CLASS C – SHOCK AND HEAT SENSITIVE

Highly reactive and can auto-polymerize as a result of internal peroxide accumulation. The peroxides formed in these reactions are extremely shock- and heat-sensitive.

- Acrylic acid
- Acrylonitrile
- Butadiene (gas)
- Chloroprene
- Chlorotrifluoroethylene
- Methyl methacrylate
- Styrene Vinylpyridine
- Tetrafluoroethylene (gas)
- Vinyl acetate
- Vinylacetylene (gas)
- Vinyladiene chloride
- Vinyl chloride (gas)

CLASS D – POTENTIAL PEROXIDE FORMING CHEMICALS

May form peroxides but cannot be clearly categorized in Class A, B, or C.

- Acrolein
- Allyl ether
- Allyl ethyl ether
- Allyl phenyl ether
- p-(n-Amyloxy)benzoyl chloride
- n-Amyl ether
- Benzyl n-butyl ether
- Benzyl ether
- Benzyl ethyl ether
- Benzyl methyl ether
- Benzyl-1-napthyl ether
- 1,2-Bis(2-chloroethoxyl)ethane
- Bis(2-ethoxyethyl)ether
- Bis(2-(methoxyethoxy)ethyl) ether
- Bis(2-chloroethyl) ether
- Bis(2-ethoxyethyl) adipate
- Bis(2-methoxyethyl) carbonate
- Bis(2-methoxyethyl) ether
- Bis(2-methoxyethyl) phthalate
- Bis(2-methoxymethyl) adipate
- Bis(2-n-butoxyethyl) phthalate
- Bis(2-phenoxyethyl) ether
- Bis(4-chlorobutyl) ether
- Bis(chloromethyl) ether
- 2-Bromomethyl ethyl ether
- beta-Bromophenetole
- p-Chlorophenetole
- Cyclooctene
- Cyclopropyl methyl ether
- Diallyl ether
- p-Di-n-butoxybenzene
- 1,2-Dibenzyloxyethane
- p-Dibenzyloxybenzene
- 1,2-Dichloroethyl ethyl ether
- 2,4-Dichlorophenetole
- Diethoxymethane
- 2,2-Diethoxypropane
- Diethyl ethoxymethylenemalonate
- Diethyl fumarate
- Diethyl acetal
- Diethylketene
- Diethoxybenzene (m-,o-,p-)
- 1,2-Diethoxyethane
- Dimethoxymethane
- 1,1-Dimethoxyethane
- Di(1-propynl) ether
- Di(2-propynl) ether
- Di-n-propoxymethane
- 1,2-Epoxy-3-isopropoxypropane
- 1,2-Epoxy-3-phenoxypropane
- p-Ethoxyacetophenone
- 1-(2-Ethoxyethoxy)ethyl acetate
- 4,5-Hexadien-2-yn-1-ol
- n-Hexyl ether
- o.p-Iodophenetole
- Isoamyl benzyl ether
- Isoamyl ether
- Isobutyl vinyl ether
- Isophorone
- b-Isopropoxypropionitrile
- Isopropyl-2,4,5-trichlorophenoxy acetate
- n-Methylphenetole
- 2-Methyltetrahydrofuran
- 3-Methoxy-1-butyl acetate
- 2-Methoxyethanol
- 3-Methoxyethyl acetate
- 2-Methoxyethyl vinyl ether
- Methoxy-1,3,5,7-cyclooctatetraene
- b-Methoxypropionitrile
- m-Nitrophenetole
- 1-Octene
- Oxybis(2-ethyl acetate)
- Oxybis(2-ethyl benzoate)
- b,b-Oxydipropionitrile
- 1-Pentene
- Phenoxyacetyl chloride
- a-Phenoxypropionyl chloride
- Phenyl-o-propyl ether

- o-Bromophenetole
- p-Bromophenetole
- 3-Bromopropyl phenyl ether
- tert-Butyl methyl ether
- n-Butyl phenyl ether
- n-Butyl vinyl ether
- Chloroacetaldehyde diethylacetal
- 2-Chlorobutadiene
- 1-(2-Chloroethoxy)-2-phenoxyethane
- Chloroethylene
- Chloromethyl methyl ether
- beta-Chlorophenetole
- o-Chorophenol
- 2-Ethoxyethyl acetate
- (2-Ethoxyethyl)-a-benzoyl benzoate
- 1-Ethoxynaphthalene
- o,p-Ethoxyphenyl isocyanate
- 1-Ethoxy-2-propyne
- 3-Ethoxypropionitrile
- 2-Ethylacrylaldehyde oxime
- 2-Ethylbutanol
- Ethyl-b-ethoxypropionate
- Ethylene glycol monomethyl ether
- 2-Ethylhexanal
- Ethyl vinyl ether
- 2,5-Hexadiyn-1-ol
- p-Phenylphenetone
- n-Propyl ether
- n-Propyl isopropyl ether
- Sodium 8-11-14-eicosatetraenoate
- Sodium ethoxyacetylide
- Tetrahydropyran
- Triethylene glycol diacetate
- Triethylene glycol dipropionate
- 1,3,3-Trimethoxypropene
- 1,1,2,3-Tetrachloro-1,3-butadiene
- 4-Vinyl cyclohexene
- Vinylene carbonate

References

National Safety Council: Data Sheet I-655 Rev. 87
NFPA: NFPA 432, Code for the Storage of Organic Peroxide Formulations
Reactive Hazards Reduction, Inc. http://www.rhr-inc.com/
FDNY: New York City Fire Code

The Sleeping Giant

Many of us are surrounded by compressed gas cylinders. Here is a reminder of just what respect they command.

GET TO KNOW ME

I can contain very high pressure.
I wear a label to identify the gas I am holding.
My color does not tell you what gas I contain.
I am only one piece of a two-part system. Without a correct regulator or manifold I cannot function safely.

KNOW HOW TO USE ME

Know how to safely install and remove me from your system.
Make sure I am properly secured when in use and when stored.
Open my valve slowly when I am to be used.
Close my valve when you are done.
Know the dangers of my contents, read the MSDS, and follow proper procedures when using me.

WHEN THINGS GO WRONG

If my valve or regulator snaps off, all my power is unleashed through an opening no larger than a pencil.

I will jet away faster than any dragster.
I will smash through brick walls.
I will spin, ricochet, crash and splash through anything in my path.

TO BE MY MASTER REMEMBER

Secure me,
Cap me, and
Always follow recommended safety procedures.

Compressed Gas Association

For more information, contact your nearest CGA member:

APPENDIX D

Employee "Right to Know" Program

New Employee Safety Notifications

The College of Earth and Mineral Sciences, in conjunction with The Pennsylvania State University is dedicated to promoting safety awareness among its employees. To that end we require the following notifications and programs be offered to all employees. Mandatory training is identified as such.

Workers Compensation Employee Notification

❑ ALL employees, at the time of review must sign a copy of the "Workers Compensation Employee Notification." This form can be obtained at: http://guru.psu.edu/gfug/instruct/4-03ex.pdf

Employee Right to Know Training

❑ ALL employees must be offered annual Employee Right to Know Training. This training is offered through the PSU Environmental Health & Safety Office, at Eisenhower Parking Deck. See the EHS web homepage at http://www.ehs.psu.edu/to schedule training.

Chemical Waste Management Training

❑ ALL employees who are not "strictly clerical staff or individuals working exclusively with computers" are required to take Chemical Waste Management Training, offered through the PSU Environmental Health and Safety Office at Eisenhower Parking Deck. See the EHS web homepage at http://www.ehs.psu.edu/to schedule training.

EMS Safety Manual

❑ All incoming employees are advised that the College of Earth and Mineral Sciences has adopted a College Safety Manual to help promote safety awareness and to serve as a basic guideline in protecting the personal safety of all EMS employees. The most up to date version of this manual is available electronically on the EHS web site at: http://www.ems.psu.edu/safetymanual/Hard copies of this manual are available through your department, and are located in all laboratories. To help familiarize yourself with the contents of this manual, you are expected to take an open book quiz. This quiz will be offered through your department.

Your Signature below signifies that you have been made aware of the above safety requirements of PSU and EMS. It also signifies your agreement to comply with those requirements set forth and others imposed by your specific work group or department.

_____ _____