University of Maryland Center for Environmental Science

Appalachian Laboratory

Laboratory Safety Guide/Chemical Hygiene Plan

April 2013

EMERGENCY TELEPHONE NUMBERS

FSU Campus Police	301-687-4222
Fire, Ambulance, Law Enforcement	9-1-1 OR 911
Poison Control Hotline (for information after 911 call)	1-800-222-1222
Western Maryland Health System	240-964-1200
Emergency Response Program – Hazardous & Oil Spills	1-866-633-4686

ASSISTANCE TELEPHONE NUMBERS

Katie Kline, Lab Manager	301-689-7122 (office) 301-689-8439 (home) 301-707-2365 (cell)
Tim Hockman	301-707-5251 (cell)
Heather Johnson, Assistant Director	301-689-7111 (office) 301-707-1705 (cell) 301-689-6892 (home)

FOREWORD

Overall safety in the lab is EVERY LAB USER'S responsibility. Each individual has an obligation to maintain, to the best of their ability, a safe work environment. It is suggested that one method of maintaining a safe work place is to actively incorporate these safety practices into your laboratory activities. As a guide, these practices will help identify potential hazards in the lab, and will provide a reminder of routine safety requirements.

The Laboratory Safety Guide incorporates both general guidelines as well as more in-depth information about specific laboratory safety practices. Please refer to the Table of Contents for topics of interest to you or which pertain to your laboratory. Remember, if you can't find an answer, the Chemical Safety Committee or Chemical Hygiene Officer will try to help you.

Usage of the laboratories by students for their research is considered to be a privilege, not a right. Every laboratory is supervised by a faculty member. Therefore, rules for laboratory and equipment use will vary from lab to lab. It is the responsibility of the student or staff member to obtain permission from the appropriate faculty member to use a laboratory facility, learn the rules that have been established for that particular laboratory, follow these rules, and work in as safe of a manner as possible. Violation of safety or other usage rules in a particular laboratory will result in suspension of user privileges, either for a specific laboratory or the facility as a whole. Keep in mind that all rules established by the AL Safety Committee supercede any individual laboratory safety rules.

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SAFETY CHECKLIST FOR LABORATORY USERS

Please read the following questions and think carefully about your answers.

1. Do you wash your hands before leaving the laboratory?
2. Do you wear appropriate attire in the laboratory (lab coat, safety goggles, gloves, shoes)?
3. Are the appropriate hazard signs and emergency numbers posted on the outside of the laboratory door?
4. Are all containers in your lab properly labeled? Do you know how to interpret these labels?
5. Do you know where to find Material Safety Data Sheets (MSDSs) for all chemicals used in your laboratory?
6. Are the chemicals in your lab properly stored?
7. Have you been instructed in the proper use and handling of the chemicals in your laboratory?
8. Have you been instructed in the location and use of safety devices (safety showers, eye washes, laboratory hoods, etc.) in your laboratory?
9. Are you aware of emergency procedures in the event of a chemical exposure, spill, fire or explosion?
10. Do you know how to properly segregate and dispose of chemicals you will use?
11. Are all mechanical engineering controls (e.g., fume hoods) operating properly?
12. Do you know who to notify if working in a laboratory alone after normal hours?
13. Have you attended Chemical Hygiene Plan training provided by the Safety Officer?
14. Have you attended laboratory specific training provided by your Laboratory Supervisor?
15. Do you know where your laboratory Standard Operating Procedures (SOP) are stored and how to use them?
16. Are you familiar with the protocol you are following? Do you feel comfortable performing the procedure without additional information or demonstration?

If you answered NO to any of these questions, read this laboratory safety guide and if you still have questions, see your laboratory supervisor or contact Katie Kline, the Chemical Hygiene Officer (Ext. 7122) for assistance.

I. GENERAL LABORATORY SAFETY PRACTICES

The purpose of this guide is to promote safety awareness and encourage safe work practices in the laboratory. These are guidelines; they should serve as a reminder of things you can do to work more safely. Although these guidelines are applicable to all research, teaching and academic laboratories at the Appalachian Laboratory, your lab may require more specialized rules that apply to specific materials and equipment. Please see your Laboratory Supervisor (LS) or Principal Investigator (PI) for more information before beginning work in the lab.

A. **Awareness**

* Be alert to unsafe conditions and actions, and call attention to them so that corrections can be made as soon as possible.

* Label all storage areas, refrigerators, etc., appropriately, and keep all chemicals in properly labeled containers.

* Date all bottles of chemicals when received **and** when opened.

* Note expiration dates on chemicals.

* Note special storage conditions.

* Be familiar with the appropriate protective measures to take when exposed to the following classes of hazardous materials. Information is available from your lab supervisor, the Chemical Hygiene Officer (Ext. 7122) and the Safety Committee.

    - Flammables
    - Radioactive Compounds
    - Corrosives
    - Biohazards
    - Toxics
    - Carcinogens
    - Reactives
    - Compressed Gases

* Segregate chemicals by compatibility groups for storage (see Appendix II for table of incompatible chemicals).

* Be aware of the potential interactions of lab furniture and equipment with chemicals used or stored in the lab. (i.e., are oxidizers stored directly on wooden shelving?)

* Post warning signs for unusual hazards such as flammable materials, biohazards or other special problems. (i.e., ethidium bromide)

* Pour more concentrated solutions into less concentrated solutions to avoid violent reactions (i.e., always add acid to water; not water to acid).

* Avoid distracting any other worker. Practical jokes or horseplay have no place in the laboratory.

* Use equipment only for its designated purpose.

* Position and secure apparatus used for hazardous reactions in order to permit manipulation without moving the apparatus until the entire reaction is complete.

* Be sure to perform all potentially hazardous activities in a fume hood.

B. **Personal Safety**

1. Respiratory and Body Protection

* Use fume hoods whenever possible.

* Splash proof safety goggles should be worn at all times in the chemical laboratory.

* Laboratory coat/apron should be worn in the laboratory.

* Appropriate gloves should be worn as needed.

* Appropriate closed-toed shoes should be worn in the laboratory.

2. Personal Hygiene

* Wash hands before leaving laboratory.

* Launder clothing worn in laboratory separately from other clothing.

* Never mouth pipette anything in the lab.

* Never eat, drink or apply cosmetics in a laboratory or areas where chemicals/hazardous agents are stored. (Smoking is prohibited in all areas of University of Maryland buildings, including laboratories.)

* Never store food in a refrigerator where hazardous materials are stored.

* Never heat food in a laboratory oven or furnace

* Never eat or drink from laboratory glassware.

* Avoid wearing contact lenses in the laboratory.

* Avoid situating long hair, loose sleeves/cuffs, rings, bracelets, etc. in close proximity to open flames or operating machinery.

* Keep exposed skin covered. Shorts, sleeveless or short sleeve shirts, skirts or open-toe shoes should not be worn in the laboratory.

C. Fire Prevention

* Be aware of ignition sources in lab area (open flames, heat, electrical equipment).

* Purchase and store flammable reagents in the smallest quantities available.

* Store flammable liquids that require refrigeration in explosion-proof refrigerators.

* Store flammable liquids in appropriate safety cabinets and/or safety cans.

* Do not store incompatible reagents together (e.g., acids with flammables). Lists of incompatible reagents can be found in several source books (for example, Handbook of Reactive Chemical Hazards). See Appendix II for a table of some commonly-used laboratory chemicals and incompatibilities.

* Do not store ethers or conjugated dienes for extended periods of time as explosive peroxides could form. Date ethers when received and opened.

* Make sure that all electrical cords are in good condition. All electrical outlets should be grounded and should accommodate a 3-pronged plug. Never remove the grounding prong or use an adapter to bypass the grounding on an electrical cord.

* Remain out of the area of a fire or personal injury unless it is your responsibility to meet the emergency responders.

* Meet emergency responders from a safe location.

* Be aware of the condition of fire extinguishers. Report any broken seals, damage, low gauge pressure or improper mounting to the Chemical Hygiene Officer (Ext. 7122). If the seal has been broken, assume that the fire extinguisher has been used and must be recharged. (NOTE: Do not use fire extinguishers unless you are trained and feel confident to do so.) Report ALL fires by phoning 911.

* Automatic fire sprinklers must remain clear and unblocked to function properly. Do not store materials within 18" below the sprinkler head.

D. **Housekeeping**

* Eliminate safety hazards by maintaining laboratory work areas in a good state of order.

* Maintain at least two clear passages to laboratory exits.

* Always keep tables, fume hoods, floors, aisles and desks clear of unnecessary material.

* Wipe down bench tops and other laboratory surfaces after each use with an appropriate cleaning or disinfecting agent.

* All equipment should be inspected before use.

* Use borosilicate glassware for laboratory work. If dichromate/sulfuric acid glass cleaner is used in your laboratory, make sure that cleaning is confined to the fume hood as toxic chromyl chlorides are released from the dichromate/sulfuric acid solution. Better yet, switch to a non-chromate cleaning solution. (i.e., No Chromix®) which will also minimize hazardous waste generation.

* If experiments must be left unattended, place a note next to experimental apparatus indicating the chemicals involved, your name and a number where you can be reached in case of an emergency.

* Keep the laboratory floor dry at all times. Immediately attend to spills of chemicals or water, and notify other lab workers of potential slipping hazards.

* All machinery under repair or adjustment should be properly tagged prior to servicing. All service work should be performed by authorized personnel.

* Sink traps and floor drains should be flushed and filled with water on a regular basis to prevent the escape of sewer gases or the release of chemical odors in the event of an emergency. Drains which will not be routinely used may be "topped" with 20 - 30 ml of mineral oil to prevent evaporation of water in the trap.

* All compressed gas cylinders should be securely chained or clamped to a rack or fixed stationary piece of lab furniture. Mark empty cylinders, but use all safety precautions as if the cylinder were full.

E. Emergency Procedures

* In the event of an emergency, remember one number: 911. By calling this number, all necessary emergency response departments can then be alerted to your needs.

* Be familiar with the emergency evacuation plan for the building.

* Be sure the names and phone numbers of lab personnel to be contacted in an emergency are posted in the lab or outside of the door.

* Be familiar with the location, use and limitations of the following safety devices:

    1. safety shower
    2. eye wash station
    3. protective respiratory gear
    4. fume hood
    5. spill cleanup materials
    6. first aid kit
    7. fire alarm
    8. fire extinguisher

* Clean up all small spills immediately. If a large chemical spill occurs, try to contact the Chemical Hygiene Officer (by phone). Be prepared to provide information about the magnitude of the spill. If you are unable to reach the Chemical Hygiene Officer (CHO), call the campus emergency phone number, 911. If the spill poses a hazard to individuals outside of the laboratory, follow the laboratory's emergency standard operating procedure. Stop current reactions or equipment if possible, activate the building fire alarm, exit the building, call 911 to report the emergency and stand by at a safe distance to provide information to emergency response personnel.

* If volatile, flammable, or toxic materials spill, shut off flames and spark-producing equipment at once and evacuate.

* In the event of fire or explosion, activate the building fire alarm, exit the building, dial 911 to report the emergency and standby in a safe location to meet emergency responders.

* Do not cover windows of laboratory doors, except for special experimental requirements. This allows passers-by to notice if anyone is in need of emergency assistance.

* Maintain a clear path to all safety equipment at all times.

F. **Waste Disposal**

* MINIMIZE WASTES at the source by limiting the quantities of materials purchased and used.

* Segregate and prepare chemical wastes for disposal in accordance with the procedures issued by the Chemical Safety Committee.

* Dispose of all waste in designated containers. There are many different types of containers used at the AL for the collection of wastes. Know which ones are appropriate for the wastes you generate. Questions may be directed to the CHO (Ext. 7122).

G. **Miscellaneous**

* Children and pets should not be brought into the laboratory (see AL visitor policy).

* If work is being conducted after hours, let other laboratory personnel (or someone that schedule phone check-in times) know of your presence. Make sure that the person that is checking on you knows what to do if you can't be reached. If possible, avoid carrying out experimental laboratory work in an unoccupied lab.

II. SAFETY EQUIPMENT

An expanding array of federal, state, and local laws and regulations make the protection of worker health and safety a legal requirement as well as an economic necessity. In the final analysis, personal and laboratory safety can be achieved only by informed, responsible individuals. This section summarizes various forms of personal and laboratory safety equipment. Based on this information, knowledgeable choices for appropriate personal protection in the laboratory can be made.

A. Personal Protective Equipment (PPE)

Personal protective equipment includes such things as gloves, eye protection, and respirators. Each individual laboratory should establish rules concerning required PPE based on the activities that will be performed in that laboratory. Background information about PPE is provided in this guide, but it is up to each individual user to learn about the chemicals they will be using and the best PPE for those activities. Questions about appropriate PPE for your activities can be directed to the Chemical Hygiene Officer.

Personal and laboratory safety can only be achieved by informed, responsible individuals. This means reading and understanding the MSDS for the chemicals that you use, discussing any potential hazards with your supervisor, and asking the Chemical Hygiene Officer if you have any further questions concerning proper PPE for your activities in the laboratory.

1. Eye Protection

It is easy to take your senses for granted since they function without conscious thought. It's easy to relax your guard in the laboratory environment. After all, for those people not used to wearing glasses, it can be regarded as a burdensome task to wear unattractive, often restrictive eyewear. However, the chemical laboratory is likely to be the most health-threatening place that you can encounter. Thousands of people are blinded each year from work-related eye injuries. Most would have been prevented if people had used eye or face protection.

Splashing chemicals and flying objects are possible at any time in the lab environment. For this reason, eye protection is an important consideration. Protective eyewear for personnel and visitors should be splash proof. They must meet ANSI (American National Standards Institute) specifications. Approved eyewear usually bears an ANSI approval stamp on the lens or eyepiece of the eyewear.

You should have the appropriate eye protection available to you when you are working in the laboratory. If you don't have safety glasses, tell your supervisor. They can be purchased from any safety supply company.

Types of eye/face protection that can be available for use are safety glasses, splash goggles, and face shields. Face shields alone, though, are not considered to be adequate protection. Always use safety glasses or splash goggles when using a face shield.

Use and Maintenance

* Eye wear should be as comfortable as possible, fit snugly over the eyes and around the face, and not interfere with the movement of the wearer.

* When it is appropriate, signs should be posted outside the door stating that eye protection is required before entering the room.

* Appropriate eye protection should be worn when using:

    - caustics, corrosives, or irritants
    - glassware under vacuum or pressure (reduced or elevated)
    - cryogenic materials
    - flammable materials
    - radioactive materials
    - explosives
    - lasers (special lens protection required)
    - UV light (special lens protection required)
    - biohazards
    - carcinogens
    - toxic chemicals

* Eye protection should also be worn when performing these machine shop operations:

    - welding
    - sanding
    - grinding
    - drilling
    - sawing

* Eye safety equipment should be capable of being cleaned and disinfected.

* Eye protection should always be kept in good condition.

Corrective Lenses

Laboratory workers whose vision requires the use of corrective lenses should wear safety eye protection of one of the following types:

* Prescription lens safety splash goggles.

* Splash-proof safety eye wear that can be worn over prescription glasses without disturbing the adjustment of the glasses.

Contact Lenses

Contact lenses are not recommended for use in the lab environment and should not be routinely worn in the laboratory. Laboratory personnel who insist on wearing contact lenses while performing laboratory work should be aware of the following potential hazards:

* It may be impossible to remove contacts from the eyes following entry of some chemicals into the eye area.

* Contact lenses will interfere with emergency flushing procedures.

* Contacts may trap solid materials in the eyes.

* If chemicals contact the eye area and the laboratory worker is unconscious, rescue personnel may be unaware that contact lenses are present.

Use of contact lenses should be considered carefully, with extra consideration given to choosing eye protection that fits snugly over the eyes and around the face.

2. Protective Clothing

a. Lab Coat

The lab coat is designed to protect the clothing and skin from chemicals that may be spilled or splashed. It should always be properly fitted to the wearer and is best if it is knee length. There are several different types of lab coats for different types of protection. Consider the materials/chemicals you are using before you select your lab coat.

Some examples of protective aspects of different lab coats:

* Cotton protects against flying objects, sharp or rough edges and is usually treated with a fire retardant.

* Wool protects against splashes of molten materials, small quantities of acid, and small flames.

* Synthetic fibers protect against sparks and infrared or ultraviolet radiation. However, synthetic fiber lab coats can increase the severity of some laboratory hazards. For instance, some solvents may dissolve particular classes of synthetic fibers, thereby diminishing the protective ability of the coat. In addition, on contact with flames, some synthetic fibers will melt. This molten material can cause painful skin burns and release irritating fumes.

* Aluminized and reflective clothing protect against radiant heat.

The construction of the material must also be considered (twill, felt, plain, etc.), as the materials are rated differently by various manufacturers. Lab coats should be made with snaps or fasteners, which afford the wearer quick removal in the event of an emergency.

b. Aprons

Aprons provide additional protection when using particularly corrosive or irritating chemicals. An apron should be worn over garments that cover the arms and body, such as a lab coat.

3. Hand Protection

Gloves are used in laboratories to protect workers from accidental spills or contamination. No gloves are available to protect laboratory personnel against all potential chemical exposures. In fact, a Dartmouth researcher died in 1997 from exposure to dimethylmercury, which penetrated her latex gloves. Protection of the hands from exposure to solvents, detergents, or any other hazardous material is essential, especially from highly toxic chemicals, in preventing a toxic dose to the body. Exposure of the hands to hazardous chemicals can result in burns, chafing of the skin due to extraction of essential oils, dermatitis, and sensitization. Primary skin irritations and sensitizations account for greater numbers of lost time accidents than any other type of occupational injury. However, if the dose to a critical organ is great enough, significant adverse effects and even death can occur.

It is a good idea to always get into the habit of wearing protective gloves in the laboratory. BUT, you want to make sure that you are using the right glove for the chemical you are using or the process you are performing. Aside from acting as a shield between hands and hazardous materials, some gloves can also absorb perspiration or protect the hands from heat. Because certain glove types can dissolve in contact with solvents, it is important to take extra care in matching the protective glove with the nature of the job. Before use, check to make sure the gloves (especially latex gloves) are in good condition and free from holes, punctures, and tears.

Glove Selection

The selection of the proper glove type is essential to the performance of the glove as a barrier to chemicals. No one glove material will remain impervious to a specific chemical forever. No one glove material is resistant to all chemicals. Some chemicals will travel through, or permeate, the glove in a few seconds, while other chemicals may take days or weeks.

What is meant by permeation rate, breakthrough time, and degradation?

Permeation rate is the rate at which the chemical will move through the material. It is measure in a laboratory and is expressed in units like milligrams per square meter per second. The higher the permeation rate, the faster the chemical will move through the material. Permeation is different from penetration. Penetration occurs when the chemical leaks through seams, pinholes, and other imperfections in the material; permeation occurs when the chemical diffuses or travels through intact material.

Breakthrough time is the time it takes for a chemical to permeate completely through the material. It is determined by appplying the chemical on the glove

exterior and measuring the time it takes to detect the chemical on the inside surface. The sensitivity of the analytical instruments used in these measurements influence when a chemical is first detected. The breakthrough time gives some indication of how long a glove can be used before the chemical will permeate through the material.

Degradation is a measurement of the physical deterioration of the material due to contact with the chemical. The material may get harder, stiffer, more brittle, softer, weaker, or may swell. The worst example is that the material may actually dissolve in the chemical.

How do I choose the right material for the job?

Based on the above information, it becomes apparent that you must carefully choose the appropriate glove material for each job. The selection of the proper chemical-resistant glove begins with an evaluation of the job activities and procedures. Factors that influence the selection of proper gloves are:

* specific chemical(s) and type of chemical(s) to be used
* frequency and duration of chemical contact
* nature of contact (immersion and/or splash)
* concentration of the chemical
* temperature of the chemical
* abrasion-resistant requirements
* puncture, snag, tear, and cut-resistance requirements
* length of hand or arm to be protected
* dexterity requirements
* grip requirements and conditions, i.e., wet or oily
* type of cuff needed, i.e., safety cuff, knit wrists, or gauntlet
* color requirements, i.e., to show contamination
* thermal protection – to protect against heat and cold
* size
* comfort needs
* cost

The type of chemical used is the most important factor for selecting gloves to protect against chemical exposure, especially for highly toxic chemicals. For chemical resistance, permeation and degradation of the glove, material selection is one of the most important. Select the glove with the highest chemical resistance rating and other glove properties that best suit your application. For highly toxic chemicals, a highly resistant laminated glove, such as SilverShield or 4H, should be worn under a pair of long-cuffed, unsupported neoprene, nitrile, or similar heavy-duty gloves.

Where to find glove selection information:

VWR/Fisher Scientific Catalogs in the Gloves sections

S:/Lab Safety/Glove Perm. Guide

http://www.pp.okstate.edu/ehs/hazmat/gloves5.html

Chemical Hygiene Officer (Ext. 7122)

Appendix I of this Manual

Glove removal

Care should be taken when removing gloves. Peel the glove off the hand, starting at the wrist and working toward the fingers. Keep the working surface of the glove from contacting skin during removal. Contaminated disposable gloves should be discarded in designated containers (e.g., radioactive or biohazardous waste containers).

Wash hands as soon as possible after removing protective gloves.

4. Foot Protection

Foot protection is designed to prevent injury from corrosive chemicals, heavy objects, electrical shock, as well as giving traction on wet floors. If a corrosive chemical or heavy object were to fall on the floor, the most vulnerable portion of the body would be the feet. For this reason, shoes that COMPLETELY COVER AND PROTECT the foot are recommended.

Fabric shoes, such as tennis shoes, absorb liquids readily. If chemicals happen to spill on fabric shoes, remove footwear immediately.

When selecting footwear for the lab, choose sturdy shoes that cover the foot. These will provide the best protection.

The following shoe types should not be worn in the laboratory:

* sandals

* clogs

* high heels

* shoes that expose the foot IN ANY WAY

The following are recommended types of footwear when working in extremely hazardous situations:

* Safety Shoes (steel-toed) protect against crushing injuries caused by impact from any object during work activities (e.g., lifting heavy objects, using power tools, etc.).

* Treated Shoes, Rubber Boots or Plastic Shoe Covers protect against corrosive chemicals.

* Insulated Shoes protect against electric shock.

* Rubber Boots with slip resistant outer soles provide traction in wet conditions where the possibility of slipping exists.

* Safety Shoes, Rubber Boots or Plastic Shoe Covers protect against specific types of chemical contamination and like gloves must be selected to match the current hazard.

5. Hearing Protection

Ear protection should be worn where the noise level is above 85 decibels (dBA). Areas where excessive noise is present should be posted with signs indicating ear protection is required. Ear protectors should be readily available and rated for sufficient noise reduction.

Types of ear protection include:

* Ear plugs provide basic protection to seal the ear against noise.

* Ear muffs provide extra protection against noise, and are more comfortable than ear plugs.

* Cotton inserts are poor suppressors of noise and should be avoided.

6. Respiratory Protection

For future applications

B. **Laboratory Safety Equipment**

1. Laboratory Chemical Fume Hoods

Chemical fume hoods capture, contain, and expel emissions generated by hazardous chemicals. In general, it is a good idea to conduct all laboratory chemical experiments in a fume hood. While you may be able to predict the release of undesirable or hazardous effluents in some laboratory operations, "surprises" can always happen. Therefore, the fume hood offers an extra measure of protection.

Fume hoods are located in many of the labs on both the second and third floors. In rooms that have hoods, motion detectors have been installed. When no one is in the room, the hoods go into a power saving mode to reduce electricity use. As soon as someone enters the room, the hood should automatically return to the appropriate face velocity (100 cubic feet per minute). You should still check the face velocity every time that you use the hood. The calibration of the fume hood monitor will be checked on a routine basis by the Chemical Hygiene Officer.

Certain laboratory procedures may require the use of perchloric acid. Perchoric acid is an extremely dangerous compound because the use of this material may cause the formation of explosive perchlorate crystals. Users must be fully aware of the hazards and appropriate handling procedures before using perchloric acid. Special fume hoods, commonly known as Perchloric Acid Fume Hoods, MUST be used for this purpose. These hoods have self-contained wash-down units to inhibit crystal formation. There is a Perchloric Acid Fume Hood located in room 337. This hood should ONLY be used with perchloric acid. If you need to use perchloric acid, you must consult AL's CHO to help develop an SOP for your work.

All laboratory workers with access to a fume hood should be familiar with its use. Use the following guidelines when performing procedures in a fume hood:

Fume Hood Usage Guidelines:

* Verify from the digital control pad that the face velocity measures about 100 linear feet/minute.

* Do not place your face inside the hood. Keep hands out as much as possible.

* Keep sources of emission **6** inches inside the hood.

* Do not use the hood for storage of chemicals. Clean up spills immediately.

* Keep the sash as low as possible in order to use the sash as a safety shield.

* Prepare a plan of action in case of an emergency, especially when using extremely hazardous chemicals or acids.

* Only work the sash at the proper operating level (do not move the preset stops).

* Always wear appropriate personal protective equipment when using chemicals in the hood (i.e., gloves, apron, labcoat, face shield, safety goggles).

* Don't sit down at the hood, it puts your face directly in the fume path.

* Contact the Chemical Hygiene Officer if you suspect that a fume hood is not working properly.

When is it necessary to use a fume hood?

The laboratory fume hood is the major protective device available to laboratory workers. It is designed to capture chemicals that escape from their containers or apparatus and to remove them from the laboratory environment before they can be inhaled. Characteristics to be considered in requiring fume hood use are physical state, volatility, toxicity, flammability, eye and skin irritation, odor, and the potential for producing aerosols. A fume hood should be used if a proposed chemical procedure exhibits any one of these characteristics to a degree that (1) airborne concentrations might approach the action level (or permissible exposure limit), (2) flammable vapors might approach one tenth of the lower explosion limit, (3) materials of unknown toxicity are used or generated, or (4) the odor produced is annoying to laboratory occupants or adjacent labs.

Procedures that can generally be carried out safely outside the fume hood include those involving (1) water-based solutions of salts, dilute acids, bases, or other reagents, (2) very low volatility liquids or solids, (3) closed systems that do not allow significant escape to the laboratory environment, and (4) extremely small quantities of otherwise problematic chemicals.

Therefore, anytime you are working with chemicals or unknown materials that could potentially generate harmful fumes or vapors, you should use a fume hood. As a rule of thumb, anytime you are unsure as to whether you need to use a fume hood, you should.

2. Laboratory Ventilation

Ventilation systems in each laboratory are constantly turning the air over (about 8 times per hour). Each laboratory is negative with respect to the corridors and other labs. The ventilation system , therefore, can act as containment (i.e., in cases of spills). It is important to keep the doors closed between laboratories and into the hallways. In case of spills and accidents, this will keep harmful fumes from circulating through the entire building and requiring evacuation.

3. Chemical Storage Cabinets

* Storage of flammables and corrosives in the lab should be limited to as small a quantity as possible.

* Flammable materials should only be stored in the cabinets that are located below each fume hood.

Use and Maintenance

Chemicals should NEVER be stored in alphabetical order without consideration for chemical compatibility. This system may contribute to the probability of incompatible materials being stored next to one another (e.g., butadiene next to bromine or chlorine). Incompatible reagents should not be stored next to each other. (See the chemical incompatibility chart in Appendix II of this manual.)

Storage outside of cabinets should be limited to materials used in the current process.

The vent cap on chemical storage cabinets should not be removed unless the cabinet is attached to an approved ventilation system.

Glass containers should be stored on the bottom shelf of storage cabinets whenever possible.

Types of Cabinets

* Flammable liquid cabinets are designed for storage of flammable or combustible liquids.

* Acid/corrosive cabinets are designed for corrosion resistance.

Individual Storage Containers

Selecting the best means of storage for chemical reagents will, to a great extent, depend on that reagent's compatibility with the container.

A safety can is an approved container of no more than five gallons (19 liters) capacity. It has a spring-closing lid and spout cover, and is designed to safely relieve pressure buildup within the container.

Vent caps may be purchased for original manufacturers' glass containers to help minimize explosion hazards.

4. Refrigerators

While domestic refrigeration units are appropriate for keeping foods cold, they are not designed to meet the special hazards presented by flammable materials. Therefore, laboratory refrigerators should be carefully selected for specific chemical storage needs. To prevent potential safety hazards, the length of storage of any material should be kept to a minimum. In addition, refrigerators should be periodically inspected. Refrigerators used to house flammable materials must be approved for such use by FM® (Factory Mutual) or UL® (Underwriters Laboratory).

Use and Maintenance

Each refrigerator, freezer or other cooling unit should be prominently labeled with appropriate hazard signs to indicate whether it is suitable for storing hazardous chemicals. Label chemical hazard refrigerators with the sign "For Chemical Storage Only. No Food or Drink Allowed."

If radioactive materials are to be stored, a refrigerator must be clearly labeled "Caution, Radioactive Material. No Food or Beverages May Be Stored in This Unit."

The containers placed in the refrigerator should be completely sealed or capped, securely placed, and labeled. Avoid capping materials with aluminum foil, parafilm, corks, and glass stoppers.

Refrigerators should be frost free to prevent water drainage.

Types of Refrigerators

Because ignitable vapors can build up in refrigerators, it is important to store flammable and combustible materials in specially-designed units. These refrigerators will have self-contained electrical elements to avoid spark-induced explosions.

Explosion-proof or intrinsically safe refrigerators are specifically designed for hazardous environments, featuring enclosed motors to eliminate sparking and bear a FM or UL explosion-proof label.

Highly volatile flammable and combustible substances that require refrigeration may be stored only in explosion-proof refrigerators especially designed for such use. Such refrigerators must meet the requirements for Class 1 Division 1 Electrical Safety Code (NPFA 70 and NFPA 45) and require direct wiring to the power source via a metal conduit. The same storage requirements apply to any solution or specimen that may release flammable fumes (e.g., the ether-impregnated fur of a dead rat has been known to cause an explosion in a refrigerator).

5. Eyewash Stations

Eyewash stations provide an effective means of treatment when chemicals come in contact with the eyes. Eyewash stations are located at most sinks in the laboratories. Acquaint yourself with the location of the eyewash facilities in the laboratory and how they are operated **before** they are needed. Be prepared to help someone else wash their eyes quickly in the event of an accident since they might not be able to find or operate the station.

If you accidentally get something in your eyes, go directly to the nearest eyewash station and flush your eyes with water for 15 minutes. Be sure to hold your eyes open with your fingers and aim the water streams at the base of your nose (not directly at your eyeball).

Don't rub your eyes. You may scratch or embed particles in your eyes.

Once you have flushed your eyes, seek immediate medical attention. Make sure that emergency response personnel know the chemical(s) involved.

6. Safety Showers

Safety showers provide an effective means of treatment in the event that chemicals are spilled or splashed onto the skin or clothing. Safety showers are located right outside each laboratory and are operated by grasping the triangular rod. Do not ever pull shower handles unless needed.

When someone has been the victim of a body splash, the person(s) should be removed or remove themselves from the spill area. Individuals should remove contaminated clothing, including shoes and jewelry, while under an operating shower (not a time to be modest). Flood the affected area(s) with water for at least 15 minutes or longer if pain persists. Wash skin with mild soap and water – do not use neutralizing chemicals, creams, lotions or salves. Contact emergency response personnel and ensure that they know the chemical(s) that were involved.

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7. Fire Safety Equipment

Types of Equipment

* Fire Alarms are designed so that all endangered laboratory personnel and building occupants are alerted by an audible warning. Fire alarm activations must be reported to Emergency Assistance (911) from a safe location.

  All employees/students should become familiar with the EXACT LOCATION of the fire alarm pull stations nearest to their laboratory.

* Fire Extinguishers are spaced and located as required by current fire codes and standards. Multi-purpose fire extinguishers can be found in hallways and in most laboratories.

  Only use a fire extinguisher if the fire is very small and you know how to use the extinguisher safely. If you can't put out the fire, leave immediately. Make sure the fire department is called even if you think the fire is out.

  Occupants of labs should visually inspect lab fire extinguishers at least monthly. Units that are missing, have broken seals, low pressure or visible damage should be reported to the Safety Officer immediately for replacement.

  For fire extinguisher service, requests, training, or any questions call the Hygiene Officer (Ext. 7122).

* Sprinklers are designed to enhance life safety by controlling a fire until the fire department arrives or, in many cases, completely extinguishes a fire.

  Sprinklers are automatically activated, and laboratory workers should not attempt to shut off or tamper with the system.

C. **Laboratory Equipment Safety**

1. Glassware

Accidents involving glassware are a leading cause of laboratory injuries. These can be avoided by following a few simple procedures. In general, be certain that you have received proper instructions before you use glass equipment designed for specialized tasks that involve unusual risks or potential injury. Listed below are some safety rules.

Use and Maintenance

* Handle and store glassware carefully so as not to damage it or yourself.

* Properly discard or repair damaged items.

* When inserting glass tubing into rubber stoppers, corks or when placing rubber tubing on glass hose connections protect hands with a heavy glove or towel, lubricate tubing or stopper with water or glycerol and be sure that the ends of the glass tubing are fire-polished, hold hands close together to limit movement of glass should fracture occur substitute plastic or metal connections for glass ones whenever possible to decrease the risk of injury use glassware designed for vacuum work for that purpose

* When dealing with broken glass wear hand protection when picking up the pieces use a broom to sweep small pieces into a dustpan package it in a rigid container (i.e. corrugated cardboard box) and seal to protect personnel from injury.

* Never attempt glass-blowing operations without proper facilities.

2. Heating Devices

Electrical devices that supply heat for reactions or separations are commonly used in laboratories. Improper use could result in fire or burns to the user. Electrically heated devices include:

* hot plates
* hot-tube furnaces
* heating mantles
* hot-air guns
* oil baths
* ovens
* air baths
* water baths

Use and Maintenance

* If baths are required to be activated when not attended, they should be equipped with timer to turn them on and off at suitable hours and, if possible, a thermostat to turn off power if the unit overheats.

* Flammable or combustible solvents should never be used in a heated bath unless housed in a chemical fume hood.

* Before using any heating device:

  - check to see if the unit has an automatic shutoff in case of overheating;

  - note the condition of electrical cords and have them replaced as required;

  - make sure the apparatus has been maintained as required by the manufacturer;

  - make sure the device maintains a Underwriters' Laboratories (UL®) or Factory Mutual Engineering Division of Associated Factory Mutual Fire Insurance Companies (FM®) listing;

  - check to see that all heating units in use without automatic shut-off have been turned off before leaving an area for any extended period of time.

3. Vacuum System

Use and Maintenance

A central vacuum system is installed in the laboratories. The vacuum pump for this system is located in the mechanical room.

To activate the vacuum, use the control knob. It is important to use a trap on the suction line to prevent liquids from being drawn into the pump.

Be sure to turn the vacuum off when you are finished with it.

Glassware

Glassware used for vacuum distillations or other uses at reduced pressure must be properly chosen for its ability to withstand the external pressure of the atmosphere.

Only round-bottom vessels may be subjected to vacuum unless specially designed, such as Erlenmeyer-type filtration flasks.

Each vessel must be carefully inspected for defects such as scratches or cracks.

All vacuum operations should be carried out behind a table shield or lowered fume hood sash because all vacuum equipment is subject to failure by implosion. (Implosion occurs when atmospheric pressure propels pieces inward creating small fragments which are subsequently propelled outward with considerable force.)

4. Centrifuges

Do not attempt to operate a centrifuge until you have received instruction in its specific operation. Read the operation manual, if available, and ask an experienced colleague to demonstrate procedures.

Individual users are responsible for the condition of the centrifuge machine and rotors during and at the end of procedures. This responsibility includes proper loading, controlling speed to safe levels, safe stopping, removal of materials, and cleanup.

Ultra centrifuge rotors require special cleaning procedures to prevent scratching of surfaces, which can lead to stress points and possible rotor failure during operation.

POTENTIAL PROBLEMS TO WATCH FOR WHEN USING CENTRIFUGES

PROBLEM	EFFECT	PRECAUTION AGAINST
Unbalanced load	Damage to seals or other parts	Keep lid closed during operation and shut down and stop the rotor if you observe anything abnormal, such as: --noise --vibration
Broken tubes	Centrifuge contamination and personal injury	When loading the rotor: --examine tubes for signs of stress --discard tubes that look suspicious

III. FIRST AID AND EMERGENCY PROCEDURES

The first aid and emergency procedures detailed in this section could be life-saving. Become familiar with the information described below, so that disasters can be speedily contained. It is the responsibility of the injured employee or student to report bodily injury or property damage to AL even if a police report is filed. Supervisors of injured employees must complete the "Workers Compensation Employer's First Report of Injury or Illness" form to report on-the-job injury. Required forms and instructions can be obtain from the Business Office. The Chemical Hygiene Officer must also receive a copy of the completed form.

A. First Aid

1. Wounds

Small cuts and scratches

Direct pressure -- place sterile pad over wound and apply pressure evenly with the opposite hand.
Elevation -- if direct pressure does not control bleeding, raise the area above the level of the heart.
Cleanse area with soap and water.

Significant bleeding

Call Emergency Rescue (911).
Direct Pressure -- place sterile pad over wound and apply pressure evenly with the opposite hand.
Elevation -- if direct pressure does not control bleeding raise the area above the level of the heart.

2. Thermal Burns

First degree burns (e.g., sunburn or mild steam burn) are characterized by redness or discoloration of the skin, mild swelling and pain.

First Aid procedures for first degree burns are as follows:

a. Apply cold water applications and/or immerse in cold water for at least 10 minutes.

b. Seek further medical treatment as needed.

Second and third degree burns are characterized by red or mottled skin with blisters (second degree), white or charred skin (third degree).

First aid procedures for second and third degree burns are as follows:

a. Call Emergency Rescue (911).

3. Chemical Burns

If hazardous chemicals should come into contact with the skin or eyes, follow the first aid procedures below.

a. Skin

Remove victim's clothes -- don't let modesty stand in the way.

Remove victim's shoes -- chemicals may also collect here.

Rinse the area with large quantities of water for at least 15 minutes (sink, shower, or hose).

DO NOT apply burn ointments/spray to affected areas.

Call Emergency Rescue (911) without delay.

b. Eyes (acid/alkali, e.g., HCl, NaOH)

Call Emergency Rescue (911) without delay.

Rinse area of eyes, eyelids, and face thoroughly with lukewarm water for at least 15 minutes at the eye wash station.

4. Ingestion of Chemicals

Call Emergency Rescue (911) IMMEDIATELY.

Call the Maryland Poison Center at 1-800-222-1222 for advice on appropriate actions to be taken while awaiting emergency medical assistance.

If the victim is unconscious, turn their head or entire body onto their left side. Be prepared to start CPR if you are properly trained, but be cautious about exposing yourself to chemical poisoning via mouth-to-mouth resuscitation. If available, use a mouth-to-mask resuscitator.

5. Inhalation of Chemicals

Evacuate the area and move the victim into fresh air.

Call Emergency Rescue (911) without delay.

If the victim is not breathing and you are properly trained, perform CPR until the rescue squad arrives. Be careful to avoid exposure to chemical poisoning via mouth-to-mouth resuscitation. Use a mouth-to-mask resuscitator.

Treat for chemical burns of the eyes and skin as noted above.

B. **First Aid Kits**

First aid kits should be standard equipment in every laboratory. Commercial, cabinet-type, or unit-type first aid kits are acceptable. A typical first aid kit for laboratories includes a variety of items specially selected to carry out emergency treatment of cuts, burns, eye injuries, or sudden illness. The first aid kit should contain individually sealed packages for each type of item. Contents of the kit should be checked weekly to ensure that expended items are replaced. Laboratory supervisors are responsible for maintaining the contents of the first aid kit. Kits are available from most general safety or lab supply houses.

No oral medication (including aspirin) should be dispensed from the first aid kit.

C. **CPR & AED**

AL staff who are certified to perform CPR and have been trained to operate the AED (Automated External Defibrillator) are listed on the side of the AED storage cabinet.

D. Emergency Procedures

Planning and practicing for emergencies is an essential component of laboratory safety. Workers in labs should have the knowledge necessary to assess their risks from a small spill or release of a chemical or small trash can fire, if they have received the proper training. The most important aspect of this training is being able to differentiate between an incidental situation and an emergency. Practice in emergency procedures and evacuation drills will provide workers with the insight they need to make this differentiation.

An incidental release is one that does not cause an imminent health or safety hazard to lab workers and does not have to be cleaned up immediately to prevent death or serious injury to employees. Lab workers should prepare for and handle their own incidental spills or releases (in the proper manner).

The following is a list of emergency situations. The following definitions designate an emergency situation:

1. The situation is unclear to the person causing or discovering the spill.

2. The release requires evacuation of personnel.

3. The release involves or poses a threat of

    a. High levels of exposure to toxic substances
    b. Fire, suspected fire, explosion or other imminent danger
    c. Conditions that are Immediately Dangerous to Life and Health (IDLH)

4. The person(s) in the work area is uncertain they can handle the severity of the hazard with the personal protective equipment (PPE) and response equipment that has been provided and/or the exposure limit could easily be exceeded.

Conversely, releases that do not pose significant safety or health hazards to person(s) in the immediate vicinity or to the person(s) cleaning releases, do not have the potential to become emergencies with a short time frame are not emergency situations. The following are examples of situations that are **not** emergencies:

1. The person causing or discovering the release understands the properties and can make an informed decision as to the exposure level.

2. The release can be appropriately cleaned up by lab personnel using authorized spill kits.

3. The materials are limited in quantity, exposure potential, or toxicity and present minor safety or health hazards to persons in the immediate work area or to those assigned to clean up the activity.

4. Incidental releases of hazardous substances that are routinely cleaned up by the Safety Officer are not considered to be an emergency.

NOTE: Emergency assistance for all types of emergencies may be obtained 24 hours a day by dialing 911 from any lab phone or by activating any of the emergency blue lights on campus.

1. Chemical Spills

Spill

If the spill is of high toxicity or flammability or you are unsure of how to proceed or is more than one liter, execute the following:

* If spill occurred in the hood, press the red emergency button on the control panel.
* Evacuate personnel from the spill area and alert neighbors to the spill.
* Isolate the spill area and close doors to the room where the spill occurred.
* Remove ignition sources and shut down equipment.
* If spill occurred outside the hood, press the red emergency button on the control panel of the Sureflow room control.
* Contact the Chemical Hygiene Officer.
* Call 9-1-1 (preferably from a phone outside the lab) or activate one of the emergency panels (blue light).
* Remain available to provide information to emergency response personnel.

NOTE: If the situation is of a particularly hazardous nature and you think that it is critical that the authorities are contacted first, please do so.

Evacuation of the building is mandatory if chemicals or contaminants could enter the air circulation of the building (i.e., if the spill occurs in the hallway, cold rooms, etc.).

Mercury Spills

* Contact the CHO (Ext. 7122).

Non-emergency Spills

If the spill is less than one liter and the chemical involved is of low toxicity and a low flammable hazard, handle it in the following manner:

If you have questions about proper spill response techniques, contact the Chemical Hygiene Officer.

1. Locate the spill kit.
2. Choose the proper personal protective equipment.
   * Always wear gloves and protective eye wear.
   * Use additional PPP such as an apron, coveralls, or boots.
   * Use a fitted respirator if there is an inhalation hazard above the permissible exposure limit.
3. Confine or contain the spill

For non-reactive spills:

A. Cover liquid spills with spill kit absorbent and scoop into a plastic disposal bag.
B. Sweep solid materials into a dust pan and place in a sealed container.
C. Dispose of waste as normal trash as long as substance is non-volatile, non-hazardous.

For reactive or potentially reactive spills:

A. Cover liquid spill with spill kit absorbent and scoop into an appropriate disposal container.
B. Wet mop dry substances to avoid spreading hazardous dust, provided it is non-water reactive.
C. If spilled chemical is a volatile solvent, transfer disposal bag to a hood for evaporation of solvent.
D. Contact Safety Committee for disposal procedures.

Acid Spills

Apply neutralizer (or sodium bicarbonate) to perimeter of spill.

Mix thoroughly until fizzing and evolution of gas ceases. NOTE: It may be necessary to add water to the mixture to complete the reaction. Neutralizer has a tendency to absorb acid before fully neutralizing it.

Check mixture with pH indicator paper to assure that the acid has been neutralized.

Transfer the mixture to a plastic bag, tie shut, fill out a waste label, and place in the fume hood. Notify supervisor or contact the Chemical Hygiene Officer for proper disposal procedures.

Caustic Spills

Apply neutralizer to perimeter of spill.

Mix thoroughly until fizzing and evolution of gas ceases.

Check mixture with pH indicator paper to assure that the material has been completely neutralized.

Transfer the mixture to a plastic bag, tie shut, fill out a waste label, and place in the fume hood. Notify supervisor or call the Safety Officer for disposal.

Solvent Spills

Apply activated charcoal to the perimeter of the spill.

Mix thoroughly until material is dry and no evidence of liquid solvent remains.

Transfer absorbed solvent to a plastic bag (if compatible), tie shut, fill out and attach a waste label, and place in the fume hood. Notify supervisor or call the AL Safety Officer for disposal.

2. Power Outages

We do have back-up power, but there will be a delay before the ventilation in the labs comes back on. When the power goes out and you are working in laboratory, evacuate the room **after** the following steps have been taken:

* Place lids on all open containers of volatile chemicals.
* Lower the sash on chemical fume hoods.
* Shut down all equipment.
* Turn off ignition sources.
* Secure or isolate reactions that are underway (boiling liquid on a hot plate)
* Close all doors to room.
* Lock outside door to lab.

If laboratory ventilation does not come back on within **15 minutes**, the entire building will need to be evacuated.

3. Medical Emergency

* Dial 9-1-1 or activate one of the emergency panels (blue light)

* Contact a faculty or staff member that is certified to perform CPR, if necessary.

4. Fire Safety

Written Plan

All personnel, especially lab supervisors and faculty, must be knowledgeable of the AL Policy Concerning Fire Emergencies (see Appendix IV). This official policy describes the procedures occupants must take in the event of fire or other emergencies.

Laboratory supervisors should develop a plan which incorporates specific instructions relating to their laboratories into the UMCP Policy Concerning Fire Emergencies. Specific instructions should include:

* Location of exits and emergency escape routes.
* Locations of fire alarm pull stations and emergency phones.
* Operations to be shut down, turned off or secured before evacuation without placing personnel in danger.
* A location for laboratory personnel to meet and the procedure to account for personnel after an evacuation.
* Laboratory supervisors should review the plan with new employees and students and annually with all personnel.

A laboratory-specific fire emergency plan should be posted in each laboratory.

IV. PROPERTIES OF HAZARDOUS CHEMICALS

A. Flammability

Flammability is a measure of how easily a gas, liquid, or solid will ignite and how quickly the flame, once started, will spread. The more readily ignition occurs, the more flammable the material. Flammable liquids themselves are not flammable; rather, the vapor from the liquids are combustible. There are two physical properties of a material which indicate its flammability: flash point and volatility (boiling point).

The flash point of a material is the temperature at which a liquid (or volatile solid) gives off vapor in quantities significant enough to form an ignitable mixture with air. Given an external source of ignition (i.e., spark, flame), a material can ignite at temperatures at or above its flash point. The flash point of ethyl ether, a highly flammable solvent, is –49°F. Kerosene has a flash point between 100°F and 150°F. Flammable gases have no flash point, since they are already in an ignitable form.

The volatility of a material is an indication of how easily the liquid or solid will pass into the vapor stage. Volatility is measured by the boiling point of the material -- the temperature at which the vapor pressure of the material is equal to the atmospheric pressure. The term volatility is often mistakenly used as a synonym for flammability. There are some materials that are volatile but not flammable such as water, chloroform and mercury.

Some materials are pyrophoric, meaning that they can ignite spontaneously with no external source of ignition. Potassium metal, for example, can react with the moisture in air. This reaction causes hydrogen gas to be evolved, and the heat generated by the reaction can be hot enough to ignite the hydrogen.

Examples of commonly-used flammable chemicals:

acetone
ethyl ether
sodium
hydrogen
lithium
acetylene
ethyl alcohol
potassium

Labeling & Information

* Each container of flammable liquid should be properly labeled before use.

* Product flammability may be indicated on the label by a picture of a flame, a flame in a red diamond, a numeric code in a NFPA Hazard Rating system diamond or by the words flammable or combustible.

* Flammability information can be found on the MSDS under Fire and Explosion Data. Flash point and boiling point information can be found in the section entitled Physical Properties.

Storage

* Flammable materials should never be stored near acids or oxidizers.

* Keep storage areas cool to decrease the possibility of formation of vapors in excess of the lower flammable limit for the material or autoignition in the event that vapors mix with air. Adequate ventilation should be provided to prevent vapor build-up under normal storage conditions.

* Do not store flammable materials in conventional (non-explosion proof) refrigerators. Sparks generated by internal lights or thermostats may ignite flammable material inside the refrigerator, causing an extremely dangerous explosion hazard.

* Storage areas should have spill cleanup materials and an emergency plan nearby, including the location of the nearest fire alarm pull station. **Do not** attempt to extinguish a fire in a flammables storage area.

* Storage areas should be inspected periodically for deficiencies, and storage of flammable materials should be kept to a minimum.

* "NO SMOKING" signs should be clearly posted where flammable materials are stored.

- Flammable liquids can be separated into 3 classifications based on their flash point and boiling point. Based on these classifications, NFPA has published limits for maximum size and quantity of specific flammable liquid storage containers. OSHA standards enforce these limits for storage in laboratories. They are summarized in the following table:

	Flammability (degrees F)		Max. Size Per Container Type				
	Flash Point	Boiling Point	Glass	Metal	Plastic	Safety Can*	Flammable Cabinet**
Flammable Liquids							
Class IA	Below 73	Below 100	1 pt.	1 gal.	1 gal.	2 gal.	60 gal.
Class IB	Below 73	Above 100	1 qt.	5 gal.	5 gal.	5 gal.	60 gal.
Class IC	73-100	N/A	1 gal.	5 gal.	5 gal.	5 gal.	60 gal.
Combustible Liquids							
Class II	100-140	N/A	1 gal.	5 gal.	5 gal.	5 gal.	60 gal.
Class IIIA	140-200	N/A	5 gal.	5 gal.	5 gal.	5 gal.	120 gal.
Class IIIB	>200	N/A	5 gal.	5 gal.	5 gal.	5 gal.	N/A

* U.L. Approved

** Max. 3 cabinets per fire area

A maximum of 10 gal. of class I and/or II liquids may be stored in any fire area outside of safety cans.

A maximum of 25 gal. of class I and/or II liquids may be stored in any fire area inside of safety cans.

Handling

* Use gloves and splash-proof safety goggles when handling flammable liquids.

* Mixtures of flammable or combustible liquids should be treated as though the mixture had the lowest flash point represented.

* Dispensing of flammable or combustible liquids should only be carried out under a fume hood or in an approved storage room.

* When transferring or using a flammable liquid, all ignition sources should be eliminated from the area. Open flames or hot plates should NOT be used to directly heat flammable liquids.

* **DO NOT use water to clean up flammable liquid spills.**

* **DO NOT dispose of flammable or combustible liquids in the sink or drain.**

* Follow disposal procedures issued by the Safety Officer in the "AL Hazardous and Regulated Waste Management Manual".

* "NO SMOKING" signs should be posted where flammable liquids are being handled.

B. **Corrosivity**

Gases, liquids, and solids can exhibit the hazardous property of corrosivity. Corrosive materials can burn, irritate, or destructively attack skin. When inhaled or ingested, lung and stomach tissue are affected. Corrosive gases are readily absorbed into the body through skin contact and inhalation. Corrosive liquids are frequently used in the laboratory and have a high potential to cause external injury to the body. Corrosive solids often cause delayed injury. Because corrosive solids dissolve rapidly in moisture on the skin and in the respiratory system, the effects of corrosive solids depend largely on the duration of contact.

Materials with corrosive properties can be either acidic (low pH) or basic (high pH). Examples of corrosives are listed below:

sulfuric acid
hydrochloric acid
nitric acid
ammonium hydroxide
sodium hydroxide
chromium trioxide

Labeling & Information

* The corrosive label normally depicts the corrosion of a hand and bar of steel.

* Information on corrosivity can be found in the MSDS under Health Effects and First Aid.

Storage

* Segregate acids from bases, and corrosive materials from both organic and flammable materials.

* Store corrosive materials near the floor to minimize the danger of falling from shelves.

* Store in cool, dry, well-ventilated areas and away from sunlight. The storage area should not be subject to rapid temperature changes.

Handling

* Wear adequate protective equipment (lab apron, appropriate gloves and splash-proof eye protection). If splashing is a definite hazard, face shields must also be worn.

* Corrosive materials should be handled in a fume hood to protect the user from the possible generation of hazardous or noxious fumes.

* Add reagents **slowly**. **Always add acids to water** (never water to acid). During the addition of reagents, allow acid to run down the side of the container and mix slowly.

* Corrosive materials should be transported in unbreakable containers.

* For cleaning corrosive spills, refer to Emergency Procedures.

C. Reactivity

1. Explosives

Explosive materials are chemicals that cause a sudden, almost instantaneous release of large or small amounts of pressure, gas and heat when subjected to sudden shock, pressure or high temperature.

Some substances, under certain conditions of shock, temperature or chemical reaction, can explode violently. Such explosions present many hazards to laboratory personnel.

* flying glass can seriously lacerate skin
* fires can result from burning gases
* corrosive or toxic substances can be liberated

Before working with explosive materials, understand their chemical properties, know the products of side reactions, the incompatibility of certain chemicals, and monitor possible environmental catalysts (such as temperature changes).

Examples of materials that may be explosive under some conditions of use:

* acetylene
* azide
* hydrogen
* nitro compounds
* ammonia
* organic peroxides
* perchlorates
* bromates

Labeling & Information

Information on explosives can be found on the MSDS under Fire and Explosion Data.

Storage & Handling

Explosion hazards.

AVOID:

* allowing picric acid to dry out
* mixing flammable chemicals with oxidants
* flammable gas leaks
* heating compressed or liquified gas
* uncontrollable or fluctuating temperatures during experiments
* using explosive chemicals bringing hot liquid (e.g., oil) into
* sudden contact with a material possessing a lower boiling point
* contacting flammable materials with catalysts (e.g., acids or bases catalyze an explosive polymerization of acrolein)
* explosive peroxide generation products that build up in solvent containers during storage
* mixing nitric acid with acetone
* distilling ethers unless free from peroxides

* Carefully plan a procedure for working with explosive materials.

* Insert experimental apparatus into a dry glove box or gas blanket.

* Minimize storage of ethers.

* Keep specified fire extinguishing equipment near the explosive chemical work space.

* Determine all explosive hazards prior to experimental work, including the stability of reactants/products.

* For more information, contact the Chemical Hygiene Officer.

2. Oxidizers

An oxidizing agent is a chemical used to provide oxygen for chemical reactions. Oxidizers spontaneously evolve oxygen at room or slightly elevated temperatures, and can explode violently when shocked or heated. Because they possess varying degrees of chemical instability, oxidizing agents are explosively unpredictable and, therefore, represent a particularly hazardous safety threat.

Examples of oxidizing agents:

* peroxides
* hyperperoxides
* peroxyesters

Oxidizers can react violently when in contact with organics. For this reason, avoid interactions between oxidizers and organic materials. Examples of organic-reactive oxidizers include nitric acid, chromic acid, and permanganates.

Peroxides

Some organic compounds, such as ethers, can react with oxygen from the air, forming unstable peroxides. Peroxide formation can occur under conditions of normal storage, when compounds become concentrated by evaporation, or when mixed with other compounds. The accumulated peroxides can then violently explode when exposed to shock, friction, or heat. Pure compounds will accumulate peroxides more readily than compounds containing impurities.

Examples of organic compounds that form hazardous peroxides:

* aldehydes, ketones
* ethers
* compounds with allylene (CH2 = CHCH2R) structure
* alkali metals, alkoxides, amines
* vinyl and vinylidene compounds
* compounds with benzylic hydrogen atoms

Examples of chemicals which form hazardous peroxides during exposure to air:

* ethyl vinyl ether
* p-Dioxane
* decalin
* ethyl ether
* tetralin
* isopropyl ether
* tetrahydrofuran (THF)

Destruction of the listed chemicals is recommended within 1 year of chemical receipt or 1 month after opening without any testing for peroxide content.[1]

[1]Accident case Histories, Chemical Manufacturers Association, Washington, DC, 1971. No. 1693 as reprinted in Improving Safety in the Chemical Laboratory, Ed. Jay Young, JohnWiley & sons, Inc., NY, 1991, pg. 116.

Acetal
Diethyl ether
Allyl ether
Diethyl fumarate
Allyl phenyl ether
Dioxane
Isoamyl benzyl ether
1,3-Dioxepane
Benzyl n-butyl ether
1,2-Epoxy-3-isopropoxypropane
Dibenzyl ether
Benzyl ethyl ether
Isophorone
Benzyl 1-naphthyl ether
Dimethoxymethane
p-Dibenzyloxybenzene
2,2-Dimethoxypropane
1,2-Dibenzyloxyethane
1,3,3-Trimethoxypropene
Chloroacetaldehydediethylacetal
Di-n-propoxymethane
2-Chlorobutadiene
beta-Isopropoxyproprionitrile
Cyclohexene
Diisopropyl ether
Cyclooctene
n-Propyl isopropyl ether
Decalin
Tetralin
Diethoxymethane
Vinylidene chloride

Discard opened containers of peroxidizable compounds not listed above within 12 months or minimum expiration date provided by the manufacturer if less than 12 months. For disposal procedures, contact the Chemical Hygiene Officer.

Labeling & Information

* A pictorial oxidizer label depicts a flaming letter "O" on a yellow background.

* Information on oxidizing agents can be found on the MSDS under the heading Reactivity Data.

Storage & Handling

* Order ether in small quantities and use quickly.

* Include the date of purchase on containers of peroxidizable compounds. Note the date of opening on the label.

* When possible, store peroxidizable compounds (except certain inhibited vinyl monomers) under a nitrogen atmosphere. Keep away from heat, light, and ignition sources.

* Store in a cool, dry, well-ventilated area, out of direct sunlight. Protect from extreme temperatures and rapid temperature changes. DO NOT SMOKE near oxidizers.

* Store in amber glass or inert containers, preferably unbreakable. Containers should be tightly sealed. DO NOT use corks or rubber stoppers to cap containers.

* Before opening glass bottles, look for the presence of solids (crystals) or viscous liquid at the bottom of the bottle. These are good indicators of peroxide formation. **Do not** open a container that is suspect – contact the Chemical Hygiene Officer with questions.

* Isolate reactive chemicals from incompatible materials.

  organic materials
  flammable solvents
  corrosives (i.e., nitric, chromic acids)

* Avoid friction, grinding and all forms of impact while working with oxidizers.

* Avoid mixing oxidizing agents with other chemicals during disposal procedures.

* To detect the presence of peroxides, the following procedure can be used. In a 25ml glass-stoppered cylinder (colorless, protected from the light), add 1 ml of freshly prepared 10% aqueous potassium iodide solution to 10 ml of organic solvent. View the cylinder transversely against a white background. If a yellow or brown color appears, peroxide is present. Contact the Chemical Hygiene Officer for disposal or any other questions.

D. **Toxicity**

The concept of toxicity is unique because it can be applicable to all chemical substances used in the laboratory. The terminology explained below can assist laboratory workers in assessing the degree of hazard and provide guidance in the selection of appropriate personal protective equipment.

Toxicity is defined as the ability of a substance to cause: damage to living tissue, impairment of the central nervous system, severe illness, or in extreme cases, death when ingested, inhaled, or absorbed through the skin.

The administration of a particular dosage of a chemical, and the subsequent response by experimental animals, can help predict that chemical's toxic effect on humans. The dose-response behavior is represented by a dose-response curve, which demonstrates that not all individuals will respond to a particular dose of a chemical in the same manner. Some people will be more sensitive than others and a specific dosage that may be lethal to one person may not be lethal to another.

The point on the curve where 50% of the test animals have died as a result of a particular chemical dosage is referred to as the Lethal Dose50, or LD50. The LD50 is usually indicated in terms of milligrams of substance ingested per kilogram of body weight (mg/kg). The lower the LD50, the more toxic the material.

Inhalation of toxic substances can cause a great deal of tissue damage. Each lung is composed of a large surface area of folded tissue, which is vulnerable to assault by toxic vapors and airborne particles. The toxicity of a substance via inhalation is represented by TLVs,(Threshold Limit Values) or PELs (Permissible Exposure Limits). TLVs are compiled by the American Conference of Governmental Industrial Hygienists (ACGIH) based on available research, and are considered the industry standards. PELs are determined by the Occupational Safety and Health Administration (OSHA) and promulgated as enforceable standards.

Both measures are expressed in parts per million (ppm) of the substance in air, or milligrams of substance per cubic meter of air.

The exposure limits are identified as time-weighted averages (TWA) and the short-term exposure limits (STEL) or ceilings (C).

The TWA of a substance is the average concentration to which an average worker can be exposed throughout an eight-hour work day without adverse effects. An important point to keep in mind is that the adverse effects of over-exposure to a material can range from headache or nausea to more severe disabilities. For this reason, time-weighted averages should be considered only as a guide in controlling health hazards in the laboratory, not as definitive marks between "safe" and "dangerous" concentrations.

The STEL of a substance is the maximum amount to which an average worker can be exposed in a fifteen-minute period without adverse effects. Again, this is intended only as a rough guideline.

The Ceiling limit of a substance is the concentration that should not be exceeded during any part of the work day.

The toxicity of a substance via skin absorption can be determined several ways. Often, the threshold limit values of a substance will have a "skin" notation, indicating they are rapidly absorbed through the skin. Absorption can also be indicated by the solubility of the material in water. Materials that are extremely soluble in water can dissolve in skin moisture and be transported through the skin's surface. For instance, dimethyl sulfoxide (DMSO) rapidly absorbs into the skin. If any toxic materials are present in this solvent or on the surface of the
skin, DMSO will transport these contaminants into the body as well.

A substance can have either acute or chronic toxicity. A substance that is acutely toxic will have immediate effects on the health of an over-exposed individual, (e.g., phosgene causes immediate throat irritation at a concentration of 3 ppm and immediate death at 50 ppm). A substance that has chronic toxicity will eventually affect the health of a person due to long-term exposure to that material (e.g., phosgene in concentrations less than 1 ppm over a long period of time are a potential trigger for emphysema).

E. Poisons

A poisonous compound is a substance that causes death or serious injury if relatively small amounts are inhaled, ingested or have contacted the skin. All substances can be in some quantity or condition of use.

Labeling & Information

Any substance that carries the international poison symbol (skull and crossbones) should be treated as hazardous.

Information on the poisonous nature of chemicals can be found in the MSDS section Health Hazard Data.

Storage & Handling

* Treat poisonous compounds with extreme caution. Wear protective lab coats, gloves and safety glasses, and work in a functioning fume hood.

* For specific substance information call the Maryland Poison Control Center at 1-800-492-2414.

V. SPECIAL CLASSES OF MATERIALS

A. Carcinogens

Carcinogens are substances that will cause cancer in humans or animals given appropriate exposures. Suspect carcinogens are substances that have chemical similarities with known carcinogens or have shown preliminary evidence of carcinogenic activity. Carcinogens can represent an insidious hazard in the laboratory since they can cause disease with exposures that do not produce acute toxic effects. There may be a long latency period between exposure and the appearance of cancer.

The consequence of exposure to carcinogens varies according to the species, the physiological and metabolic state of the organism, and the dosage of the carcinogen (including duration and route of exposure, concurrent exposure to other agents, and other factors). There is continuing scientific debate regarding the minimum exposure required to produce cancer, as well as the relevance of experimentally-induced animal cancers to a human situation. The complex interaction of such determinants makes risk assessment of human exposure to carcinogens exceedingly difficult. Due to these uncertainties, assurance of laboratory safety requires strict limitation of human exposure to carcinogenic substances.

Some compounds are carcinogenic only in combination with certain other compounds. It is known that particular chemicals promote the carcinogenic action of others. Since the potential for synergistic action of most chemicals is unknown, it is essential that caution be exercised with all organic compounds and metals when used in combination with carcinogens.

Labeling & Information

The following terms, defined by the International Agency for Research on Cancer (IARC), are used to describe material carcinogenicity:

Sufficient positive: Those chemicals that were found to promote and increase incidence of malignant tumors in multiple species or strains of lab animals.

Limited positive: Those chemicals found to promote either malignant tumors in a single strain, or benign tumors in single or multiple species or strains.

Inadequate: Insufficient evidence to make a decision.

Equivocal: Almost no supporting evidence.

Negative: Limited or sufficient significant negative evidence.

Examples of known or suspected carcinogens are listed below. The risk factor associated with these compounds is high, and alternative compounds should be used whenever possible.

4-Nitrobiphenyl
alpha- and beta- Naphthylamine *
Methylchloromethyl ether
3,3'-Dichlorobenzidine *
bis(chloromethyl) ether *
Chloroform *
Benzidine *
4-Aminodiphenyl
Ethyleneimine *
beta-Propiolactone
Benzene *
Dimethylaminoazobenzene
Vinyl chloride *
1,2-dibromo-3-chloropropane *
Arsenic *
Acrylonitrile *
N-Nitrosodimethylamine *
Formaldehyde *

* Designates a "Listed Hazardous Waste" (EPA).

The Occupational Safety and Health Administration (OSHA) regulates the carcinogens listed below:

2-Acetylaminofluorene
4-Dimethylaminoazobenzene
Acrylonitrile
Ethylenimine
4-Aminodiphenyl
Inorganic arsenic
Asbestos
4,4'-Methylene bis(2-chloroaniline)
Benzene
Methyl chloromethyl ether
bis-Chloromethyl ether
beta-Naphthylamine
Coke oven emissions
4-Nitrobiphenyl
1,2-dibromo-3-chloropropane
n-Nitrosodimethylamine
3,3'-Dichlorobenzidine and its salts
beta-Propiolactone
Vinyl chloride
alpha-Naphthylamine
Benizidine

Note: Anyone contemplating work with these carcinogens must contact the Chemical Safety Committee to make arrangements for initial environmental monitoring or engineering control evaluation. Depending on the results, laboratories may be required to meet the OSHA regulations on training, recordkeeping, personal monitoring and medical surveillance.

Access Control

* Entrances into areas where known carcinogens are used should be posted appropriately, such as: "Cancer Suspect Agent, Authorized Personnel Only".

* Laboratory Supervisors/Principal Investigators are required to designate locations within the lab for use of carcinogens. The designation must include consideration of necessary control measures.

* Allow only authorized persons in the laboratory. Close all doors and restrict traffic in the work area when the carcinogen is being used.

* Place warning labels such as "Carcinogen" or "Cancer Suspect Agent" on all stock, dilution, and hazardous waste disposal containers.

* Visitors should be notified about carcinogen use in the laboratory work area.

* Housekeeping personnel must be informed of any possible hazards or special cleaning procedures that are required.

* All work with carcinogens should stop and the area and equipment decontaminated before maintenance personnel are permitted to repair or work on equipment, drains, or ventilation ducts.

Personnel Protection

* In some high-risk operations involving carcinogens, a clean room or vestibule may need to be and shower constructed and properly used when entering and exiting a work area.

* Wear protective clothing when handling carcinogens, preferably disposable, such as

    gloves
    lab coats
    respirators

* Do not wear used PPE outside of the laboratory.

* Under normal working conditions, no carcinogen should contact gloves or clothing. They are the last line of defense.

* Check the manufacturer's description to be sure that the type of glove or respirator planned to be worn truly forms a barrier against the carcinogen being used. This is particularly true when using organic solvents, acids and bases.

* Use mechanical pipettes only.

* There should be no eating, drinking, smoking or other unnecessary hand-to-mouth contact.

* Only small amounts of carcinogens should be kept in stock. Only minimal amounts should be kept at work stations.

* Wash hands with soap after procedures involving a carcinogen.

Storage & Handling

* Containers of carcinogens should be clearly labeled and kept in a separate (preferably locked) storage location. Designated work areas appropriate for carcinogen use should be clearly demarcated.

* Conduct work practices involving volatiles, aerosols or dust in a chemical fume hood exhausted to the exterior so that the possibility of entry into the supply air intake of any building is minimized.

* Check fume hoods, biological safety cabinets (laminar flow hoods) and glove boxes for leaks, air-flow rate and air-flow patterns prior to using them. Follow-up with periodic checks.

* All work surfaces on which carcinogens are used should be stainless steel or covered with plastic trays or dry absorbent plastic-backed paper.

* Laboratory supervisors are responsible for training laboratory workers on proper carcinogen-handling techniques.

* Each laboratory worker must adhere to proper operations, emergency procedures, monitoring of lab work and required medical examinations. Medical records must be accurately maintained when working with carcinogens.

* Before working with suspected or known carcinogenic compounds, obtain health hazard information for each compound. In addition, compile spill cleanup emergency procedures for your laboratory.

B. Mutagens and Teratogens

1. Mutagens

Mutagens are chemical and physical agents that induce mutations in DNA and in living cells. This affects the genetic system in such a way as to cause cancer or hereditary changes in chromosomes. Individuals exposed to chemicals with mutagenic properties may develop genetic damage to the extent that future offspring may be affected.

Two forms of somatic (body/organ) cell interference may be noted.

Leukemias: White blood cells are produced far more rapidly than they can be removed from the blood, interfering with normal body functions.

Cancers: Cells that do not normally divide during adult life begin to proliferate to the extent that such division displaces or invades normal tissues.

Examples of **mutagens**:

Arsenic
Ionizing Radiation (gamma, x-rays)
Ethidium Bromide
Alkylating agents (i.e.,dimethyl sulfate)

2. **Teratogens**

Teratogens are chemical and physical agents that interfere with normal embryonic development. Teratogens differ from mutagens in that there must be a developing fetus. Damage to the fetus (embryo) is most likely to occur early in pregnancy, during the first 8 - 10 weeks. Teratogens may produce congenital malformations or death of the fetus without inducing damage to the pregnant woman.

In general, carcinogenic chemicals should be considered as a hazard to reproductive health. Even though OSHA has established exposure limits for dangerous materials, a developing fetus may be adversely affected by lower doses than those considered acceptable for adult exposure. Toxicology is still not well developed to evaluate reproductive health hazards. However, as of 1985, OSHA has identified three substances as teratogens:

Dibromochloropropane
Lead
Ethylene oxide

Examples of several other materials that are thought to be associated with reproductive health disorders are listed below.

Antimony
Carbon disulfide
Ethylene thiourea
Polychlorinated biphenols (PCBs)
Nitrous oxide
Formaldehyde
Ethylene dibromide
Ionizing radiation

Handling & Storage

* See precautions as listed under carcinogens.

* Before working with suspected or known mutagenic or teratogenic compounds, obtain health hazard information for each compound. In addition, compile spill cleanup emergency procedures for your laboratory.

* Exercise extreme caution, as you would with carcinogens. Wear personal protective clothing and equipment, and work in a well ventilated area.

C. **Compressed Gases**

The purpose of this section is to assist the laboratory worker with identification, storage, maintenance and handling of compressed gases. Compressed gases can be hazardous because each cylinder contains large amounts of energy and may have high flammability and toxicity potential.

Labeling & Information

* Compressed gas containers may be labeled in five ways:

  flammable gases are designated by a flame on a red label;
  non-flammable gas labels depict a gas canister on a green background
  poison gas labels depict a skull and crossbones
  oxygen-containing gases are designated by the letter "o"
  chlorine gas is distinctly labeled.

* Know the contents of the cylinder(s) you are working with and be familiar with the properties of the gas.

* The contents of the cylinder or compressed gas should be clearly marked and identified with proper labels or tags on the shoulder of the cylinder. Those cylinders or compressed gases that do not comply with identification requirements should be returned to the manufacturer.

* If two labels are associated with one cylinder, affix the labels 180 degrees apart on the shoulder of each cylinder. Label all empty cylinders "EMPTY" or "MT" and date the tag.

* Treat an empty cylinder in the same manner that you would if it were full.

* All regulators, gauges, valves, manifolds, must be designed for the particular pressures and gases involved. They should bear the inspection seal of either Underwriters' Laboratories (UL®) or Factory Mutual Engineering Division of Associated Factory Mutual Fire Insurance Companies (FM®).

Storage & Handling

* All cylinders should be stored in cool, dry, well-ventilated surroundings and away from all flammable substances including oil, greases, and gasoline. DO NOT subject any part of a cylinder to a temperature higher than 125°F.

* Cylinders should not be located where objects may strike or fall on them.

* Cylinders should not be stored in damp areas, or near salt, corrosive chemicals, fumes, heat or direct sunlight.

* Store cylinders by gas type, separating oxidizing gases from flammable gases. Store flammable and oxidizing gases either 20 ft apart or separated by a 30 minute fire wall, five feet high.

* Keep a minimum number of cylinders on hand.

* All cylinders and compressed gases (full or empty) **MUST** be properly fastened and supported by straps, belts, buckles or chains to prevent them from falling and causing bodily harm or becoming a projectile. A maximum of two cylinders per restraint is preferred.

* Close valves and relieve pressure on cylinder regulators when cylinders are not in use.

* Valve handles must be in place when cylinders are in use.

* DO NOT smoke in areas where there are flammable gases.

* DO NOT extinguish a flame caused by a gas until the gas source has been shut off.

* A cylinder should only be moved while strapped to a wheel cart to ensure stability. When storing or moving cylinders, always attach safety caps.

* DO NOT heat the cylinder or place a cylinder where it may become part of an electrical circuit. Compressed gases must be handled as high-energy sources and dangerous projectiles.

* All cylinders should be checked for damage prior to use. DO NOT repair damaged cylinders yourself. Damaged or defective cylinders, valves, etc., must be taken out of use immediately and returned to the manufacturer for repair.

* Each regulator valve should be inspected annually. Never force valve or regulator connections. Threads and the configuration of valve outlets are different for each family of gases to prevent mixing of incompatible gases.

* When opening a cylinder, direct the cylinder opening away from personnel and open slowly.

* DO NOT use lubrication on valve regulators.

* Do not refill a cylinder with a material other than that originally contained in the cylinder.

* Do not alter cylinder labeling.

* Do not alter the cylinder pressure by use of an external heat source.

* If an inert, flammable or toxic gas cylinder develops a small leak at the valve, carefully remove the cylinder to a hood or open space outdoors away from any possible source of ignition and all populations. Contact the Chemical Hygiene Officer for assistance.

D. **Cryogenic Materials**

Cryogenic materials have special properties that make them particularly hazardous to use in the solid, liquid or gaseous states. They are characterized by severe low temperature (-60°C to –270°C). Cryogenic temperatures are achieved by liquefaction of gases, most commonly helium, hydrogen, nitrogen, argon, oxygen or methane.

Storage & Handling

* The severely cold temperatures associated with cryogenic liquids (-60°C to –270°C) can damage living tissue on contact and embrittle structural materials.

* Liquified under pressure, cryogenic liquids must be kept in specially designed, high-pressure vessels that contain fittings to relieve overpressure. When located in moist areas, ice formation can plug pressure release devices and pose an explosion hazard. For this reason, store vessels in a dry place and periodically check for ice formation.

* Cryogenic liquids present fire and explosion hazards. A flammable mixture, cooled in the presence of air with liquid nitrogen or liquid oxygen, can cause oxygen to condense and thereby present an explosion hazard. Keep away from ignition sources. Flammable liquids will support combustion in both the liquid and gaseous states. If allowed to depressurize, cryogenic liquids will rapidly and violently expand.

* Store and work with cryogenic liquids in a well-ventilated area to prevent the accumulation of flammable, toxic or inert gases as evaporation and condensation occurs near the cryogenic tank.

* Safety glasses and face shields should be used. For handling of cryogenic liquids, use potholders or appropriate thermal gloves. (Check with the glove manufacturer to assure the gloves will protect against the extreme temperatures of cryogenic material used.)

* Cushion glassware in a protective covering to prevent injury caused by flying glass in the event of implosion/explosion.

* Transport fragile cryogenic containers with caution -- use a hand truck if appropriate.

* Vent cryogenic storage containers outdoors or into a chemical fume hood system.

* Cryogenic gases ALWAYS pose a high pressure hazard since they are stored near boiling point. Liquid to gas evaporation causes high pressures to build up.

VI. INFORMATION AND TRAINING

University of Maryland Center for Environmental Science

Appalachian Laboratory

"Right to Know" Hazard Communication Program[1]

in compliance with

29 CFR 1910.1200
Hazard Communication

and

COMAR 09.12.33.04
Access to Information about Hazardous and Toxic Substances

Purpose

The Appalachian Laboratory (AL) is dedicated to providing safe and healthy work facilities for all employees and students, and complying with federal and state occupational health and safety standards. Administrators, managers, faculty, technical and support staff, and students all share responsibility to reduce physical and health risks encountered in the performance of normal job duties requiring the use of potentially hazardous chemicals.

The Appalachian Laboratory Right-To-Know (RTK) program is designed to ensure the communication of health and safety information to employees involved in handling and use of hazardous substances. Its purpose is to inform workers of hazards that exist or may exist in the workplace. It establishes the process for compliance with the Occupational Safety and Health Administration (OSHA) regulation "Hazard Communication", 29 CFR 1910.1200 and its Maryland State counterpart, COMAR 09.12.33.04, "Access To Information About Hazardous and Toxic Substances". Knowledge of chemicals used in the workplace and proper communication of associated hazards will help employees maintain a safe workplace.

The RTK program shall be implemented for all facilities at AL and any satellite locations where hazardous materials are stored or used by an AL employee. The following sections identify and explain the required components of the AL - RTK program.

Labeling

Every chemical manufacturer, importer or distributor must ensure that each container of product containing 1% or more (0.1% if a carcinogen) of a hazardous chemical leaving its workplace is marked with a fixed label that is legible, in English, and prominently displays the following information:

1) The identity of the hazardous chemical(s), (This information should correspond with the identity information on the product's Material Safety Data Sheet (MSDS). See MSDS below.)

2) appropriate hazard warnings (key words, pictures, and symbols may be used), and

3) the name and address of the chemical manufacturer, importer or other responsible party.

AL employees must not deface or remove the label unless the container is completely empty and has been rinsed. Any label that becomes damaged must be repaired or replaced, immediately. The label may be replaced with the above listed information hand printed in indelible ink or a pre-printed replacement label.

Temporary portable containers may be used to dispense small amounts of a product for use by an individual employee during that employee's work shift if:

1) The container is temporarily labeled with the correct name of the contents to prevent accidental misuse;

2) care is taken by the employee and supervisor to assure that chemicals are not dispensed into temporary containers that previously held an incompatible chemical unless that container has been thoroughly cleaned; and

3) the label identifying previous contents of a portable container has been removed and the container cleaned to accept a new product.

Note: No flammable material may be placed into a temporary container that is not designed to accommodate flammable materials.

Chemical Information List (CIL)

All Maryland employers must prepare a list, alphabetized by common name, which identifies all hazardous chemicals/products in the workplace. This list must indicate:

1) Chemical name and common name
2) Container size and type (quantity)
3) CAS Number
4) Manufacturer
5) NFPA Rating
6) Work area location
7) Chemical ingredients of listed products
8) Date of addition of chemical to list (if not original)

A pre-printed form is available from the AL Safety Officer to accommodate this information. Laboratories are required to produce a similar inventory under the AL Chemical Hygiene Plan. (Contact the AL Safety Officer at extension 7122 or more information.) The CIL shall be used to assure that MSDS's are available for all chemicals used on the AL campus.

The CIL must be updated within 30 days by the area supervisor of any chemical change in the work area. The supervisor must forward a copy of changes to AL Safety Officer for inclusion into the AL master CIL. The AL Safety Officer will provide copies of the master CIL to the State of Maryland Department of the Environment as required.

Material Safety Data Sheets (MSDS)

Material Safety Data Sheets (MSDS) are chemical information sheets prepared by the manufacturer or distributor of any chemical or mixture that contains a hazardous chemical as 1% or more of its content (or 0.1% if the hazardous chemical is carcinogenic). The manufacturer or distributor is required to supply a MSDS with the initial shipment of each chemical. A copy of the MSDS must be maintained by the employer (AL) for each hazardous chemical listed on the CIL. The supervisor is responsible for assuring MSDSs are available for chemicals listed on each work area's CIL. The Safety Officer can assist supervisors in obtaining copies of MSDSs when provided with a completed CIL.

Access to Information

Access to the AL CIL is available through the AL Safety Officer to employees, employee representatives, emergency and medical service providers, and regulators upon request.

MSDS are available from a variety of campus sources on a 24 hour basis:

1) in the AL library, reference section (hard copies available for photocopying);

2) through the UMCP web site:
http://www.inform.umd.edu/CampusInfo/Departments/EnvirSafety/rtk/msds.html;

3) through the Vermont SIRI (Safety Information Resources on the Internet) web site
http://hazard.com/msds/
a site searchable by manufacturer, chemical name, trade name and Chemical Abstracts Series (CAS) number (a number of links to MSDS and other safety related sites are available using this web site);

4) through Fisher Scientific's web site ***http://www.fisher1.com*** (Fisher chemical MSDS's only);

5) each laboratory is strongly encouraged to maintain copies of MSDS's for the hazardous chemicals it utilizes.

There is no standard format for MSDS's but they are required to include at least the following categories of information:

1) The manufacturer's name, address, chemical information telephone number and emergency telephone number (may be same as the general information number);

2) The identity (chemical and common names, mixtures etc) and date of preparation of MSDS or latest revision date;

3) Identify the hazards (hazard category, health implications, medical conditions affected, acute and chronic affects, routes of entry);

4) First-aid procedures;

5) Fire fighting measures (e.g., explosion or fire potentials; extinguishing media);

6) Accidental release measures (spill control procedures);

7) Handling and storage;

8) Exposure control methods (recommended personal protective equipment including hand, eye, face, and respiratory protection). Available exposure limits (as mandated by OSHA standards, if available, and/or recommended by other available sources such as the American Conference of Governmental Industrial Hygienists or specific published research);

9) Physical and chemical characteristics (e.g., boiling point, vapor density, flash point, etc.)

10) Stability and reactivity data (recommended storage, chemical incompatibilities, conditions to avoid, decomposition products)

11) Toxicity information (carcinogen status, LD50, reference studies);

12) Ecological information (ecotoxicity, target organism(s) LC50);

13) Disposal considerations (EPA waste codes if applicable);

14) Transport information (D.O.T. requirements for shipping the material);

15) Regulatory information (all authorities having regulatory control of the material, local, state, federal and international);

16) Additional information (as necessary).

Training

Information and training are provided to AL employees in the following ways:

1) All employees receive an RTK information bulletin providing basic Right-To-Know information including the content of the standard, hazard identification information and information resources, through an annual campus mailing.

2) The AL Safety Officer provides RTK training on a scheduled basis. Training is open to all AL employees but required for employees (including graduate students and volunteers) who work with or around hazardous chemicals in the course of normal job duties. Call the AL Safety Officer at extension 7122 to arrange for RTK training.

Employee RTK and general safety training is provided free of charge. Supervisors are required to allow employees to attend RTK and safety initial training. Annual retraining may be provided by the AL Safety Officer, if necessary.

Trade Secrets

AL recognizes the chemical manufacturer's right to maintain trade secrets in order to protect individual markets for unique products. However, AL reserves the right to contact chemical manufacturers through the AL Safety Officer to access trade secret information for products where the information is required for employee hazard evaluation.

Manufacturers claiming a trade secret exemption must disclose related hazard warnings on the product MSDS.

Outside Contractors

Contractors who bid on projects at AL are required to submit a copy of their Hazard Communication plan and photocopies of all pertinent MSDS's whenever the work requires that hazardous chemicals be brought onto AL property. All contractors must comply with all applicable Federal and State health and safety regulations while on AL property. Contractors must also have copies of MSDS's on site while the work is being performed. Employees who need to access chemical information related to contractor activity should contact the AL Safety Officer, AL's Assistant Director or the contractor's site superintendent.

Contractors who need access to the AL RTK program or MSDS's may obtain copies through the AL Safety Officer. See "Access to Information" section.

Non-routine Tasks

Employees who must perform non-routine tasks must be informed of the hazards of that task by their supervisor before being required to perform the task. Information provided must include MSDS's for related hazardous chemicals as well as a description of other physical or health hazards associated with the task and methods of protecting themselves from those hazards through written Standard Operating Procedures (SOP's). Contact the AL Safety Officer at extension 7122 for chemical information, job hazard identification or employee training assistance.

Duties and Responsibilities

The AL Safety Committee and the AL Safety Officer shall:

1) Develop and maintain a written RTK program;

2) Provide basic information about the RTK program to all AL employees;

3) Provide general training about the RTK program and basic chemical information to all employees who may reasonably be expected to encounter hazardous chemicals in the course of normal job duties and create a record of employee participation in such training;

4) Maintain a central resource file of Material Safety Data Sheets (MSDS's) for known hazardous chemicals used in AL workplaces;

5) Assist supervisors in accessing MSDS from chemical manufacturers and distributors;

6) Provide technical guidance to personnel at all levels of responsibility concerning the RTK program, hazard evaluation, hazard control or hazardous chemical information;

7) Review the RTK program and revise as necessary.

AL Administration shall:

1) Assure that all employees have received and reviewed the RTK bulletin provided by the AL Safety Officer.

2) Assure that all employees who work with hazardous chemicals as part of their normally assigned job duties attend RTK training provided by the AL Safety Officer.

3) Assure that all employees who request RTK training, regardless of hazardous chemical use in normal job duties, are provided an opportunity to attend.

4) Identify sub-units for RTK information compilation if applicable; (e.g., the Business Office and Administration may choose to operate as a single unit since few hazardous chemicals will be used while each Principle Investigator must compile and store RTK information by lab.)

Supervisors/Academic Advisors shall:

1) Compile a Chemical Information List (CIL) of all chemicals used in the workplace;

2) Assure that employees are aware of the hazards or potential hazards associated with the chemicals in the work area under their control;

3) Assure that employees know how and where to access MSDS's for the listed chemicals and under their control during the hours in which the employee works.

4) Develop and implement standard operating procedures (SOP's) and engineering controls to promote safe practices when dealing with hazardous chemicals in the workplace to protect the employees.

5) Provide the appropriate personal protective equipment (e. g., gloves, goggles) as necessary to promote safe practices when employees must deal with hazardous chemicals in the workplace.

6) Report any problem associated with implementation of the RTK program in their work area to the AL Safety Committee or the AL Safety Officer.

7) Assure that hazardous chemicals used in the workplace are labeled per the requirements of this program.

8) Maintain the Chemical Information List (CIL) current within 30 days; send updates to the AL Safety Officer as new chemicals or products are acquired or removed from the workplace.

9) Assure that all employees who work with or around hazardous chemicals in the course of the performance of their normal job duties attend Employee RTK training offered by the AL Safety Officer. Allow all employees, regardless of hazardous chemical contact, to attend RTK training.

10) Assure that all employees who are required to perform non-routine tasks are informed of the associated hazards and provided with associated chemical information before being required to perform such tasks.

Employees shall:

1) Perform work in the safest manner possible.

2) Follow all SOP's developed by the supervisor.

3) Comply with all applicable provisions of the RTK program to include that the employee:

   a) Attend required RTK training and be familiar with the RTK information bulletin provided by the AL Safety Officer.

   b) Shall not remove or deface labels on containers and assure that damaged labels are replaced or repaired.

   c) Ask for further information about chemicals or procedures not fully understood.

   d) Report new chemicals/products discovered in the workplace to the supervisor and the AL Safety Officer so that they may be included on the Chemical Information List and a MSDS acquired.

   e) Report any existing health or safety hazard to the supervisor and AL Safety Committee or AL Safety Officer.

   f) Identify hazards before you work with a hazardous material.

   g) Not to be afraid to ask questions.

   h) Use protective clothing and equipment.

Employee Rights:

You have the right by law to:

1) See the Chemical Information List and Material Safety Data Sheets within one day of our request.

2) Be trained on the hazards of the chemicals in your workplace, the appropriate equipment and methods to use to protect you from the hazards and emergency procedures.

3) Refuse to work with a specific hazardous chemical if you are denied access to information about that chemical.

4) Refuse to work with hazardous chemicals if your employer has not provided the proper personal protective equipment.

Appendix I
Glove Resistance Guide

	Silver Shield (4 Mil)			Viton (9 Mil)			Butyl (17 Mil)			Nitrile (11 Mil)			Neoprene (22 Mil)			PVC (20 Mil)		
Chemical	**D**	**BT**	**PR**	**D**	**BT**	**PR**	**D**	**BT**	**PR**	**D**	**BT**	**PR**	**D**	**BT**	**PR**	**D**	**BT**	**PR**
Acetaldehyde	E	>6h	ND	P	0m	282	E	9.6	0.07	F	4m	161	E	21m	18	ID	ID	ID
Acetone	E	>6h	ND	P	ID	ID	E	>17h	ND	P	ID	ID	E	12m	35	P	>1m	
Acetonitrile	E	>8h	ND	ID	ID	ID	E	>8h	ND	ID	ID	ID	E	40m	7	ID	ID	ID
Acrylic Acid	ID	ID	ID	G	5.9h	0.23	E	>8h	ND	F	ID	ID	ID	ID	ID	ID	ID	ID
Acrylonitrile	E	ID	ID	F	1m	176	G	3.1h	>.01	P	3m	176	ID	ID	ID	ID	ID	ID
Aldehyde	E	>6h	ND	P	0m	282	E	9.5h	0.07	P	4	161	ID	ID	ID	ID	ID	ID
Aniline	E	>8h	ID	G	10m	18.7	F	>8h	ND	P	1.1h	45	E	>8h	ND	G	>8h	ND
Benzaldehyde	ID	ID	ID	F	9.9h	4	E	9h	ND	P	ID	ID	ID	ID	ID	ID	ID	ID
Benzene	E	>8h	ND	G	6h	0.01	P	31m	32.3	P	ID	ID	ID	16m	133	ID	2m	250
Benzoyl Chloride	ID	ID	ID	E	>8h	ND	F	6.2h	16.6	P	ID	ID	ID	ID	ID	ID	ID	ID
Bromobenzene	E	ID	ID	E	8h	ND	P	32m	39.8	P	13m	9.1	ID	ID	ID	ID	ID	ID
Butyl Acetate	E	>6h	ND	P	ID	ID	G	1.9h	7.61	P	29m	54	ID	52m	53	ID	ID	ID
p-t Butyltoluene	E	>8h	ND	E	>8h	ND	G	1.7h	8	P	ID	ID	ID	ID	ID	ID	ID	ID
Butyraldehyde	E	ID	ID	P	54m	9	E	>15h	ND	P	ID	ID	ID	ID	ID	ID	ID	ID
Carbon Disulfide	G	>8h	ND	E	>8h	ND	P	7m	98	P	1m	51	ID	ID	ID	ID	ID	ID
Carbon Tetrachloride	E	>6h	ND	E	>13h	ND	P	ID	ID	G	3.4h	5	F	31m	252	ID	ID	ID
Cellosolve	G	>6h	ND	F	ID	ID	G	ID	ID	P	ID	ID	E	5.9h	3	ID	ID	ID
Chloroform	P	10m	0.01	E	9.5h	0.46	P	ID	ID	P	4m	352	P	12m	220	ID	ID	ID
Chloroprene	ID	ID	ID	ID	>8h	ND	P	28m	18	ID	ID	ID	ID	ID	ID	ID	ID	ID
Cyclohexane	E	>6h	ND	E	>7h	ND	P	1.1h	20.3	P	ID	ID	E	2.7h	7	ID	16m	17
Cyclohexanol	E	>6h	ND	E	>8h	ND	E	>11h	ND	E	>16h	ND	ID	ID	ID	ID	ID	ID
Cyclohexanone	E	>6h	ND	P	29m	86.3	E	>16h	ND	P	ID	ID	ID	ID	ID	ID	ID	ID
Dibutylphthalate	E	>6h	ND	E	>8h	ND	E	>16h	ND	E	>16h	ND	ID	ID	ID	ID	ID	ID
1,1,Dichloroethane	ID	2.4h	6	G	1.5h	31	ID	ID	ID	P	ID	ID	ID	ID	ID	ID	ID	ID
1,2,Dichlorothane	E	>6h	ND	E	6.9	0.81	P	2h	53	P	8m	311	P	33m	247	ID	ID	ID
Diethylamine	E	>8h	ND	P	35m	852	P	47m	46	F	ID	ID	ID	ID	ID	ID	ID	ID
Diethylaminoethanol	E	ID	ID	E	>8h	ND	E	>8H	ND	E	>8h	ND	ID	ID	ID	ID	ID	ID
Ether	ID	>6h	ND	P	12m	21.5	P	8m	92.2	P	14m	21.8	ID	ID	ID	ID	ID	ID
Ethyl Acetate	E	>6h	ND	P	ID	ID	G	7.6h	3.4	P	8m	145	G	34m	178	ID	ID	ID

Glove Perm Chart, continued	Silver Shield (4 Mil)			Viton (9 Mil)			Butyl (17 Mil)			Nitrile (11 Mil)			Neoprene (22 Mil)			PVC (20 Mil)		
Chemical	**D**	**BT**	**PR**	**D**	**BT**	**PR**	**D**	**BT**	**PR**	**D**	**BT**	**PR**	**D**	**BT**	**PR**	**D**	**BT**	**PR**
Ethyl Ether	ID	>6h	ND	P	12m	21.5	P	8m	92.2	P	14m	21.8	E	18m	51	ID	ID	ID
Ethylamine 70%	E	47m	7.64	P	ID	ID	E	>12h	ND	F	1.1h	30	ID	ID	ID	ID	ID	ID
Ethylene dibromide	E	ID	ID	E	>8h	ND	F	3.3h	6	P	ID	ID	ID	ID	ID	ID	ID	ID
Formaldehyde 37%	E	>6h	ND	E	>16h	ND	E	16h	ND	E	>21h	ND	E	>8h	ND	G	8h	ND
Furan	ID	ID	ID	P	20m	23	P	1.3h	10	P	ID	ID	ID	ID	ID	ID	ID	ID
Glutaraldehyde	E	ID	ID	E	>8h	ND	E	>8h	ND	P	ID	ID	ID	ID	ID	ID	ID	ID
n-Hexane	E	>6h	ND	ID	>11h	ND	P	ID	ID	E	ID	ID	E	39m	5	ID	ID	ID
Hydrazine 70%	G	>6h	ND	P	ID	ID	E	>8h	ND	G	>8h	ND	E	>8h	ND	E	8h	ND
Hydrochloric Acid 37%	E	>6h	ND	E	ID	ID	E	ID	ID	P	ID	ID	E	>8h	ND	E	>8h	ND
Hydrofluoric Acid 50%	G	>6h	ND	G	ID	ID	F	ID	ID	P	ID	ID	E	>8h	ND	E	1.8h	0
Isobutyl Alcohol	E	ID	ID	E	>8h	ND	E	>8h	ND	G	>8h	ND	ID	ID	ID	ID	ID	ID
Methyl Chloroform	ID	>6h	ND	E	>15h	ND	P	ID	ID	P	41m	76	P	27m	197	ID	ID	ID
Methyl Cyanide	ID	>8h	ND	ID	ID	ID	E	>8h	ND	ID	ID	ID	E	40m	7	ID	ID	ID
Methyl Ethyl Ketone	E	>24h	ND	P	ID	ID	E	>8h	ND	P	ID	ID	G	22m	155	ID	1m	
Methylamine 40%	F	1.9h	2	E	>16h	ND	E	>15h	ND	G	>8h	ND	ID	ID	ID	ID	ID	ID
Methylene Chloride	G	>8h	ND	F	1h	7.32	P	24m	133	P	4m	766	F	6m	239	ID	ID	ID
Morpholine	E	>8h	ND	G	ID	97	E	>16h	ND	P	48m	206	ID	ID	ID	ID	ID	ID
Nitric Acid, 3M	E	>6h	ND	G	>8h	ID	F	ID	ID	P	ID	ID	E	>8h	ND	E	1.9h	0
Oxalic Acid	E	>8h	ND	E	>8h	ND	E	>8h	ND	G	ID	ID	ID	ID	ID	ID	ID	ID
Phenol 85%, water sat	C]>6	>6h	ND	E	ID	ND	E	>20h	ND	P	39m	>1500	E	>8h	ND	ID	32m	13
Pyridine	ID	ID	ID	P	ID	74	G	>8h	ND	P	ID	ID	ID	28m	117	ID	1m	
Sodium Hydroxide 50%	E	>6h	ND	G	ID	ID	E	ID	ID	G	ID	ID	E	>6h	ND	E	8h	ND
Sulfuric Acid, 3M	E	>6h	ND	E	ID	ID	G	ID	ID	P	ID	ID	E	>6h	ND	E	>8h	ND
Toluene	E	>6h	ND	E	>16h	ND	F	21m	22.1	P	11m	68	ID	14m	576	ID	3m	350
Vinyl Chloride	E	>8h	ND	G	4.4h	0.1	P	ID	ID	G	5.7h	0.1	ID	ID	ID	ID	ID	ID
Xylene	E	>24h	ND	E	>8h	ND	P	ID	ID	P	ID	ID	ID	23m	135	ID	4m	383

E = Excellent; G=Good; F=Fair; P=Poor; ND=None Detected; ID=Insufficient Data;
D= Degradation;
BT=Breakthrough, amount of elapsed time after initial exposure before the chemical can be analytically detected on the inside surface of the glove;
PR=Permeation Rate, expressed in $mg/m^2/sec$. PR can be used for estimating glove thickness required; for a given material, thicker is more resistant.

Appendix II
Table of Incompatible Chemicals

The following substances may react violently with one another and must be kept apart.

Chemical	**Is Incompatible With:**
Acetic Acid	Chromic acid, nitric acid, alcohols, ethylene glycol, perchloric acid, peroxides, permanganates
Acetone	Concentrated nitric and sulfuric acid mixtures
Acetylene	Chlorine, bromine, fluorine, copper, silver, mercury
Acids	Bases
Activated Carbon	Calcium hypochlorite, oxidizing agents
Alkali Metals	Water, carbon tetrachloride and other halogenated alkanes, carbon dioxide, halogens
Aluminum Alkyls	Water
Ammonia	Mercury, laboratory gas chlorine, calcium hypochlorite, iodine, bromine, hydrogen fluoride
Ammonium	Acids, powdered metals, flammable liquids, chlorates, nitrates, sulfur, fine-particulate organic nitrate or cumbustible materials
Aniline	Nitric acid, hydrogen peroxide
Azides	Acids
Bases	Acids
Bromine	See chlorine
Carbon Tetrachloride	Sodium
Chlorates	Ammonium salts, acids, powdered metals, sulfur, fine-particulate organic or combustible substances
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane, hydrogen, petroleum benzine, benzene, powdered metals
Chlorine Dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Chromic Acid	Acetic acid, maphthalene, camphor, glycerol, petroleum benzine, alcohols, flammable liquids

Copper	Acetylene, hydrogen peroxide
Cumene Hydroperoxide	Acids, both organic and inorganic
Cyanides	Acids
Flammable Liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	Store separately
Hydrocarbons	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	Nitric acid, alkali
Hydrogen Fluoride	Ammonia, laboratory gas or solution
Hydrogen Peroxide	Copper, chromium, iron, metals and metals salts, alcohols, acetone, organic substances, aniline, nitromethane, cumbustibles (solid or liquid)
Hydrogen Sulfide	Fuming nitric acid, oxidizing gases
Iodine	Acetylene, ammonia (laboratory gas or solution)
Mercury	Acetylene, ammonia
Nitric Acid, Conc.	Acetic acid, aniline, chromic acid, prussic acid, hydrogen sulfide, flammable liquids and gases
Oxalic Acid	Silver, mercury
Perchloric Acid	Acetic anhydride, bismuth and its alloys, alcohols, paper, wood
Phosphorus	Sulfur, oxygen-containing compounds with uch as chlorates
Potassium	See alkali metals
Potassium Chlorate	See chlorates
Potassium Perchlorate	See chlorates
Potassium Permanganate	Glycerol, ethylene glycol, benaldehyde, sulfuric acid
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds
Sodium	See alkali metals
Sodium Peroxide	Methanol, ethanol, glacial acetic acid, anydride, benaldehyde, carbon disulfide, glycerol, ethylene glycol, ethylacetate, methyl acetate, furfurol
Sulfides	Acids
Sulfuric Acid	Potassium chlorate, postassium perchlorate, potassium permanganate

Please note: This is not an exhaustive list of incompatible chemicals. See the specific lab standard operating procedures or your Lab Supervisor/Principal Investigator to determine additional material incompatibilities of which to be aware.

Appendix III
Formaldehyde Policy
Safe Storage, Use and Disposal of Formaldehyde at AL

Section A

USE OF FORMALDEHYDE FOR THE PRESERVATION OF SCIENTIFIC SPECIMENS

Studies indicate that formaldehyde is a potential human carcinogen, as well as a potential teratogen. Airborne concentrations above 0.1 ppm (parts per million parts of air) can cause irritation of the eyes, nose, and throat. The severity of irritation increases as concentrations increase; at 100 ppm it is immediately dangerous to life and health. Dermal contact causes various skin reactions including sensitization, potentially forcing sensitized persons to find other work.

To protect workers exposed to formaldehyde, the Occupational Safety and Health Administration (OSHA) standard (29 CFR 1910.1048) applies to formaldehyde gas, its solutions, and a variety of other material such as trioxane and paraformaldehyde. In addition to setting permissible exposure levels, exposure monitoring and training, the standard requires medical surveillance and medical removal, record keeping, regulated areas, hazard communication, emergency procedures, primary reliance on engineering and work practice to control exposure, and maintenance and selection of personal protective equipment.

All staff using formaldehyde must be familiar with the following Appalachian Laboratory guidelines for use of formaldehyde. This includes a specific set of guidelines pertaining to formaldehyde use and disposal. All parts of this document define the policy on the use of formaldehyde and must be followed.

After reading this policy, the Appalachian Laboratory requires that each employee engaged in the use of formaldehyde be individually instructed in the proper use, disposal and safety precautions regarding formaldehyde and sign a statement that he/she has been so instructed. Any questions should be addressed to the Appalachian Laboratory Safety Officer.

Usage Guidelines

The Appalachian Laboratory requires that staff members who use formaldehyde explicitly follow the guidelines listed below:

1. Use of formaldehyde is restricted to AL employees who have been interviewed by the lab safety officer. Faculty shall not allow persons in their lab to work with formaldehyde unless this condition is met.

2. Users must read manufacturers instructions that are provided on formaldehyde containers and the MSDS (available in the AL library or through the UMCP Department of Environmental Safety web page).

3. All large quantities of concentrated formaldehyde and preserved specimens (in alcohol or dilute formaldehyde) must be stored in the Chemical Storage Building. This area is under the supervision of the Appalachian Laboratory Safety Officer.

4. Formaldehyde usage at AL is restricted to laboratories that have a fume hood. Full strength, undiluted formaldehyde must be handled under a laboratory fume hood. The local ventilation system in laboratories can be used when handling small quantities of specimens preserved in 10% diluted formaldehyde (although it is recommended that this be performed under a fume hood, as well).

5. Any use of formaldehyde requires the wearing of all appropriate personal protection devices: chemical splash goggles, gloves, and a lab coat. This equipment must be made available to employees/students working with formaldehyde by their supervisor or academic advisor. Gloves should be made of an appropriate material for safe handling, such as viton, nitrile, or butyl rubber (not latex).

6. All staff members need to be familiar with the location of and instructed in the proper operation of all safety equipment available in laboratories using formaldehyde. The following materials must be located in a laboratory that uses formaldehyde:

    a) fire extinguisher
    b) eye wash and safety shower
    c) first aid kit
    d) absorbent for spills

7. Any spillage of formaldehyde, violation of Appalachian Laboratory policies, or problems must be **immediately** reported to the AL Safety Officer *and* your supervisor .

8. Containers (jars, vials) must use closures that prevent leakage of vapors or liquid contents. All jars or boxes should contain pertinent information on sample source, preservative, principal investigator.

9. Inspection (including air samples) and safety precautions for proper formaldehyde handling will be routinely performed by the AL Safety Officer at monthly intervals.

10. Concentrated formaldehyde transported to the field must be in unbreakable containers (plastic carboys). Extra care must be taken that the motion of the vehicle does not cause spills. For this reason the protective equipment described above (goggles, gloves, etc.) shall be used and, all containers well secured. Special care must be taken when live animals are being preserved, especially fishes, because they frequently will splash formaldehyde from jars. Additionally, sorbent material and/or spill pillows (enough to absorb 2X the volume of formaldehyde in use) must be readily available in the event of an accidental spill. Jars of preserved specimens to be transported in motor vehicles must be in boxes that are stowed so as to prevent any spillage or leaks into the vehicle.

11. Appropriate hazard warning labels that comply with 29 CFR 1910.1200 must be affixed to all containers that contain more than 0.1 percent of formaldehyde with the following information:

DANGER
FORMALDEHYDE
IRRITANT AND POTENTIAL CANCER HAZARD

Hazard warning labels must also be located on doors entering areas where formaldehyde or formalin is used.

12. Whenever possible, formaldehyde should be stored in a flammables storage cabinet. Formaldehyde must also be kept away from sources of heat and incompatible materials.

13. No food, medicine, and cosmetics are permitted in laboratories.

Employee Information and Training

All employees who work with formaldehyde in the laboratory or in the field must participate in a safety and formaldehyde training. The formaldehyde training must be repeated at least annually.

Medical Surveillance

Physical symptoms of overexposure to formaldehyde can include the following: irritation or sensitization of the skin and respiratory system, shortness of breath, and eye irritation. Medical surveillance is available for all employees who develop signs and symptoms of overexposure to formaldehyde and to all employees exposed to

formaldehyde in emergencies. Medical surveillance includes administration of a medical disease questionnaire. This questionnaire will then be forwarded to the employee's physician. Medical examinations will be given to any employee whose physician feels based on the information based in the questionnaire, may be at increased risk to formaldehyde exposure.

Exposure Monitoring

Whenever an operation uses formaldehyde outside of an approved laboratory fume hood, the user should contact the AL Safety Officer. Results of formaldehyde monitoring must be documented and must include dates, number, and results of testing; the methods used in testing and taking air samples; a description of any type of respirators worn (if applicable); the names and social security numbers of the people exposed. This documentation must be kept on file for at least 30 years.

Recordkeeping

Records will be kept by the Appalachian Laboratory for exposure measurements, medical surveillance, employee training, and respirator fit testing (when applicable).

In addition to the above specific guidelines related to formaldehyde use, the following attachments must be reviewed and followed explicitly by each employee engaged in formaldehyde use.

Health Hazard Information

OSHA Standard: Average 8 hour exposure --0.75 ppm.

NIOSH Recommended Limit: Average 8 hour exposure --0.75 ppm.

ACGIH Recommended Limit: Average 8 hour exposure --0.75 ppm.

Short term exposure limit (STEL): 2.0 ppm for a 15-minute period

Action Limit: 0.5 ppm for an 8-hour time weighted average

Note: There is considerable individual variation in sensitivity to formaldehyde.

Inhalation: Irritation of the nose and throat can occur after exposure of 0.25 ppm to 0.45 ppm. Levels between 0.4 ppm and 0.8 ppm can give rise to coughing and wheezing, tightness of the chest and shortness of breath. Sudden exposures to concentrations of 4 ppm may lead to irritation of lung and throat severe enough to give rise to bronchitis and laryngitis. Breathing may be impaired at levels above 10 ppm and serious lung damage may occur at 50 ppm.

Skin: Direct contact with the liquid can lead to irritation, itching, burning and drying. It is also possible to develop an allergic reaction to the compound following exposure by any routine.

Eyes: Exposure to airborne levels of formaldehyde of 0.4 ppm have brought on tearing and irritation. Small amounts of liquid in the eye can cause damage to the cornea.

Ingestion: As little as 1 liquid ounce has resulted in deaths to humans. Smaller amounts can damage the throat, stomach, and intestine resulting in nausea, vomiting, abdominal pain, and diarrhea. Accidental exposure may also cause loss of consciousness, lower blood pressure, kidney damage and, if the victim is pregnant, the possibility of the fetus being aborted.

Long term exposure: Inhalation can result in respiratory congestion with associated coughing and shortness of breath. Daily skin contact can lead to drying and scaling. Some individuals may experience allergic reactions after initial contact with the chemical. Subsequent contact may cause skin rashes and asthma and reactions may become severe if exposure persists.

Long term inhalation of high levels of formaldehyde vapor (14ppm) in rats has resulted in an elevated incidence of cancer of the nose. Genetic damage from exposure has been shown in bacteria and some insects. Whether it causes these effects in humans is uncertain.

Emergency and First Aid Instructions

Inhalation: Remove victim to fresh air. Give artificial respiration as required. Seek medical attention, if necessary.

Skin: Remove soaking clothes. Wash with large quantities of soap and water for at least 5 minutes. Seek medical attention.

Eyes: Wash with water for at least 15 minutes. Seek medical attention.

Ingestion: Seek immediate medical attention. Give oxygen or artificial respiration if necessary. Administer water, milk, or egg whites. Note: Do not give an unconscious person anything by mouth.

Note to Physician: May require supportive measures for pulmonary edema when inhaled at high levels.

Fire and Explosion Information

General: In the gaseous state, formaldehyde will burn if exposed to a source of ignition. Ignites at 185^{o}F, 85^{o}C (37%), 122^{o}F, 50^{o}C (15%).

Explosive Limits: Upper - 73%, lower - 7%.

Extinguisher: Water spray, dry chemical, alcohol foam, carbon dioxide.

Reactivity

Materials to avoid: Reacts violently with performic acid, mixtures of aniline and perchloric acid and nitrogen peroxide.

Conditions to avoid: Any contact with sources of ignition or extreme high temperatures can cause fire or explosion.

Protective Measures

Storage and handling: Indoor storage should be areas having floors pitched towards a trapped drain or a curbed retention area. Polymerization of formaldehyde solution can occur if temperature should fall below 59^{o}F.

Engineering Controls: Adequate ventilation or an entirely enclosed system shall be employed. Shower, sinks, and eyewash stations must be readily available.

Protective Clothing: (Should not be substituted for proper handing and engineering controls): Waterproof boots, gloves, and apron should be worn along with safety goggles if contact with the chemical is likely.

Protective Equipment: For levels up to 30 ppm, use chemical cartridge respirator with a full facepiece, with cartridges providing protection against formaldehyde (specific cartridges preferred), a gas mask with a canister providing protection against formaldehyde, a supplied-air respirator with a full facepiece or self-contained breathing

apparatus with a full facepiece. Up to 100 ppm, use Type C supplied-air respirator operated in positive pressure mode. For escape from a contaminated area, use a gas mask with a canister providing protection against formaldehyde or a self-contained breathing apparatus.

Procedures for Spills and Leaks

For spills < 1 gallon:

Shut off sources of ignition. Remove all workers from spill area. Wearing proper equipment and clothing spread sand, vermiculite or any other available material on spill. Sweep up and place in suitable container. For final disposal contact the AL Safety Officer.

For spills > 1 gallon:

Contact AL Safety Officer.

SHORT GUIDE TO SAFE LABORATORY PROCEDURES

This brief guide serves an introduction to prudent practice for the storage, use, and disposal of chemicals in a laboratory setting. It is not meant to be all-inclusive, but reviews some of the fundamental principles of laboratory safety as they relate to working conditions in laboratories. More detailed information on laboratory safety can be obtained from your immediate supervisor, the Safety Officer or a reference text such as Guide for Safety in the Chemical Laboratory (2nd edition), Manufacturing Chemists Associate, published by Van Nostrand Reinhold Company, 1972.

One of the most important principles of laboratory safety is to NEVER work with a compound without first learning its potential hazards. Ready sources of information are the label on the original container, the Material Safety Data Sheet (MSDS) or a standard reference work on laboratory safety such as Handbook of Laboratory Safety, CRC 1970. When in doubt, always treat an unknown reagent as hazardous. Information may be obtained from the Chemical and Radiation Safety Officer.

A second principle is to always minimize your actual or potential exposure to a chemical by using appropriate personal protective equipment. The MSDS will indicate the types of personal protection equipment necessary for a particular chemical reagent. All persons working in a lab must use the following safety equipment as appropriate:

1) eye protection (safety glasses or face shield)
2) hand protection (gloves)

3) body protection (rubber apron or lab coat; rubber boots)
4) local ventilation (be sure the fume hood that you intend to use is rated *and* approved for the chemical reagents with which you are working)

Eye protection and apron or lab coat should be worn at all times while working in the laboratory. Hand, body, and respiratory protection should be worn whenever handling hazardous reagents. Respirators may not be used *unless* approved by the Safety Officer. Base pulmonary function data must be provided by a qualified liscenced physician for each individual *and* these devices must be fit tested on the individual in order to be effective. Instead, all work involving hazardous materials (generally any full-strength acids, or organic solvents), must be conducted under a hood; gloves, aprons and eye protection must be worn.

A third principle is to familiarize yourself with the location and operation of safety equipment before working in any laboratory. Safety equipment which should be on hand includes:

1) fire extinguisher
2) fire blanket
3) eye wash
4) safety shower

If you cannot find any of these items, or are unsure about their operation, please contact your supervisor or the AL Safety Officer. In almost every case, washing with large amounts of water is the best first aid for contact with hazardous liquids or powders.

General laboratory procedures which should be followed include no mouth pipetting, adding acid to water and not vice-versa, securing all compressed gas cylinders to prevent them from falling over and always using a hood for volatiles or explosives. If you are unfamiliar with proper laboratory procedures, request instruction from your supervisor.

Safe storage and disposal of chemicals is an integral part of laboratory operation. Flammable solvents must always be stored in an explosive-proof cabinet or refrigerator, preferably with ventilation. Acids should be stored separately from organics in a ventilated area. Proper disposal procedures must be thoroughly investigated prior to using any chemical. In many instances, water-soluble compounds or those of high toxicity must be disposed of using alternate methods. Appalachian Laboratory has in effect procedures for the safe storage and disposal of hazardous wastes. Consult a copy of the procedures before initiating any laboratory project involving hazardous or potentially hazardous materials.

Appendix IV
Appalachian Laboratory Fire Policy

A. Fire

The four actions below must be taken by whoever discovers a fire that cannot be put out safely by someone who knows how to use a fire extinguisher or other life threatening situation. Actual emergency conditions may require the procedures to be followed in a different order, depending on the layout of the laboratory, time of day, the number of people present and the location of the emergency relative to doors and alarm stations or telephones.

1. Pull the fire alarm (need to become familiar with location of alarm in areas that you work).
   Alert personnel in the immediate vicinity.
   Tell them the nature and extent of the emergency.
   Give instructions to sound the alarm, close doors, call for assistance.

2. Confine the fire or emergency without endangering yourself.
   Shut hood sash if possible.
   Close doors to prevent the spread of vapors, gases, or fire.

3. Evacuate the building or hazardous area.
   Use the evacuation alarm system.
   Follow posted evacuation procedures.
   Assemble at designated meeting point.

4. Summon aid from a safe location.
   Call 911.
   Give location and type of emergency.

B. Clothing Fire and Severe Thermal Burns

Thermal burns from a clothing fire or large splash of hot material can be life-threatening if they are deep, extensive, or located on critical areas of the body. Severe burns of the hands, feet, face and genital areas are considered to be critical.

To extinguish a clothing fire:

* Stop the person on fire from running! Do not allow anyone to run, not even to a fire blanket/safety shower.

* Drop the person to the floor. Standing will allow flames to spread upward to eyes and nose.

* Roll the person to snuff out the flames. Victims should also place their hands over their face.

* DO NOT use fire extinguishers to extinguish a person that is on fire.

* Cool the person. Remove smoldering clothing. Use cold water or ice packs to cool burns and minimize injury. DO NOT put water on large burns.

* DO NOT attempt to remove clothing from burned areas.

* Keep burned areas clean and dry.

* Get medical assistance immediately.

* Keep victim calm.

C. Small Laboratory Fires

Small fires which are contained in beakers or flasks can be extinguished by covering the fire with a larger beaker if the laboratory personnel are confident to do so.

DO NOT attempt to fight a fire that cannot be extinguished immediately by covering with a larger beaker. Initiate the fire emergency procedures located in Section A.

Appendix V

GLOSSARY

Absolute
: A chemical substance that is relatively free of impurities.

Absorb
: The penetration of a solid substance by a liquid as by capillary, osmotic, solvent or chemical action. Chemicals are readily absorbed into the human blood stream through the eyes or cuts in the skin.

Acid
: An organic or inorganic compound with a pH of less than 7. Acidic materials are corrosive to human tissue.

Action Level
: A concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

Acute Toxicity
: Refers to adverse effects suffered as the result of a short, one-time exposure to toxic materials. It occurs within a relatively short period. Exposure is measured in seconds, minutes, or hours relative to inhalation or skin absorption.

Adsorb
: Collection of gas or liquid molecules on the surface of another material. For sampling of most organic vapors, activated charcoal is a good adsorber.

Base
: Chemical compounds that have a pH of greater then 7. Bases are also referred to as alkalis or caustic materials and can be corrosive to human tissue.

Boiling Point
: The temperature at which the vapor pressure of a liquid is equivalent to the surrounding atmospheric pressure, and the liquid rapidly becomes a vapor. Flammable substances possessing low boiling points are considered fire hazards.

Carcinogen

A chemical is considered to be a carcinogen if:

a. it has been evaluated by the International Agency for Research on Cancer [IARC] and found to be a carcinogen or potential carcinogen;

b. It is listed as a carcinogen or potential carcinogen in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or

c. It is regulated by OSHA as a carcinogen.

Caustic

Any strongly alkaline material that produces either corrosion or irritation to living tissue.

Chemical Hygiene Plan

A written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment, and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace.

Chemical Reactivity

The ability of a material to chemically change, possibly resulting in explosion hazards or the liberation of toxic fumes.

Chronic Toxicity

Adverse health effects resulting from repeated or long-term exposure to toxic materials.

Combustible Liquid

Any liquid having a flashpoint at or above 100F (37.8C) but below 200F (93.3C), except any mixture having components with flashpoints of 200F (93.3C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture by OSHA and NFPA definition.

Compressed Gas

a. A gas, or mixture of gases having in a container, an absolute pressure exceeding 40 psi at 70F (21.1C); or

b. A gas, or mixture of gases having in a container, an absolute pressure exceeding 104 psi at 130F (54.4C) regardless of the pressure at 70F (21.1C); or

c. A liquid having a vapor pressure exceeding 40 psi at 100F(37.8C) as determined by ASTM D-323-72.

Corrosive

A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact.

Cryogenic Liquid

Severely cold (-60C to -270C) and pressurized liquids. They present an explosion hazard due to high pressures and can cause thermal damage to living tissue.

Designated Area

An area that must be assigned by the Principle Investigator or Lab Supervisor for the use of "select carcinogens" reproductive toxins, or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

Embryotoxin

A substance shown to adversely affect a developing embryo at a particular concentration, but does not affect the pregnant female.

EPA

The Environmental Protection Agency federally regulates and enforces environmental protection.

Explosive

A chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Flammable Gas

A gas that forms a flammable mixture with air at a concentration of 13 percent by volume or less, or forms a range of flammable mixtures with air that are wider than 12% by volume, regardless of lower flammable limit.

Flammable Liquid

Any liquid having a flashpoint below 100F (37.8°C) except any mixture having components with flashpoints of 100°F (37.8°C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

Flammable Solid

A solid that is liable to cause a fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard.

Flammability

The ease with which a liquid, solid, or gas will ignite, either spontaneously (pyrophoric) or as the result of a spark or an open flame. The more flammable a material, the more readily ignition occurs.

Flashpoint

The minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite.

Fume Hood

A device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any part of the employee's body other than hands and arms.

Hazardous Chemical

A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

Highly Toxic

A chemical falling within any of the following categories:

a. A chemical that has a median lethal dose (LD50) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
b. A chemical that has a median lethal dose (LD50) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.
c. A chemical that has a median lethal concentration (LC50) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

Hood

A device/location in a laboratory, enclosed on five sides, to draw air from the laboratory and to prevent or minimize the escape of the air contaminants into the laboratory. Chemical manipulations may be conducted in the enclosure without inserting any portion of the employees body other than hands and arms.

Infectious Waste

Waste that is capable of producing disease. For waste to be considered infectious, it must contain oncogenic viruses or other pathogenic microorganisms with sufficient virulence and quantity that exposure to the waste could result in an infectious disease.

Irritant

Chemical substances that cause tissue inflammation or soreness upon absorption, inhalation, or ingestion.

LD50

The quantity of material that when ingested, injected, or applied to the skin as a single dose, will cause death of 50% of the test animals. The test conditions should be specified, the value is expressed in g/kg or mg/kg of body weight.

LEL

Lower Explosive Limit - same definition as LFL.

LFL

Lower Flammable Limit - The lower limit of flammability of a gas or vapor at ordinary ambient temperatures expressed in percent of the gas or vapor air by volume. This limit is assumed constant for temperatures up to 250°F(120°C) and is normally listed on a product's material safety data sheet.

LS

Laboratory Supervisor

MOSH

Maryland Occupational Safety and Health Administration - the state agency charged with worker health and safety. MOSH promulgates Maryland occupational safety and health standards.

MSDS

Material Safety Data Sheets are produced by chemical manufacturers and importers. They relay chemical, physical, and hazard information about specific chemicals.

Mutagen

Chemical compounds that induce mutations in DNA and living cells.

Neutralize

To alter acidic or basic compounds to a pH of 7, making it chemically neutral.

Organic Materials

Any chemical compound containing carbon.

OSHA

Occupational Safety and Health Administration - the branch of federal government charged with worker health and safety. Maryland has a state operated program that is at least as effective as the federal program maintaining jurisdiction over UMCP known by the acronym MOSH.

Oxidizer

A chemical that initiates or promotes combustion in materials, thereby causing fire either of itself or by the release of oxygen or other gases.

Oxidizing Agent

Oxygen-containing material which can decompose, generating oxygen.

PEL

Permissible Exposure Limits for the work place, set by regulation and enforced by OSHA. Most of these limit values were originally set, by consensus, by the ACGIH to assist industrial hygienists in implementing exposure control programs. As law, these are listed in 29 CFR 1910.1000 and subject to revision through the regulatory process.

PI

Principal Investigator

Poison

Any substance which is harmful to living tissue when applied in small doses. Determining factors include concentration, exposure time, particle size, the substance's affinity for tissue, and sensitivity of the exposed tissue to that compound.

Pyrophoric Material

Any solid or liquid that has the property of spontaneous ignition in air.

Radioactivity

Nuclear transformation, either by natural or artificial means, resulting in emission of energy in the form of alpha, beta, or gamma rays. Amounts of radioactive material are described by the rate of radioactive decay, the Curie (Ci), or in metric multiples and fractions thereof.

Reactivity

The proclivity of a compound to chemically react with other substances or itself, resulting in the liberation of energy. Can cause the formation of toxic or corrosive materials, pressure buildup, and temperature fluctuations.

Reproductive Toxins

Chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Sensitizer

A chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.

STEL

Short Term Exposure Limit, a 15-minute time-weighted average exposure which should not be exceeded at any time during a work day, even if the eight-hour time-weighted average is within the TLV.

Teratogen

Chemical and physical agents which interfere with normal embryonic development. Teratogens may produce congenital malformations or death of the fetus without inducing damage to the pregnant female.

TLV

Threshold Limit Value indicates the concentration of a chemical substance in the atmosphere that is considered non-hazardous in a person's normal working life.

TWA

Time Weighted Average is the concentration for a normal 8-hour working day (40 hours/week) to which workers may be exposed without anticipated adverse effect.

Toxic

A chemical falling within any of the following categories:

a. A chemical that has a median lethal dose (LD50) of more than 50 milligrams per kilogram but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

b. A chemical that has a median lethal dose (LD50) of more than 200 milligrams per kilogram but not more than 1000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.

c. A chemical that has a median lethal concentration (LC50) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than two milligrams per liter but not more than 20 milligrams per liter of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

Ultraviolet Light

Radiation in the electromagnetic spectrum with wavelengths of 100 - 3900 Ångstroms.

Volatility

The tendency of a liquid or solid to pass into the vapor state at a particular temperature.

Water Reactive

A chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

Appendix VI

REFERENCES

American Chemical Society. Safety in Academic Chemistry Laboratories, 5th Edition, 1990.

American National Standards Institute. ANSI Z358.1-1990 American National Standard For Emergency Eyewash and Shower Equipment, New York, N.Y. 1990.

American National Standards Institute. ANSI Z87.1 1989 American National Standard for Occupational and Educational Eye & Face Protection, New York, N.Y., 1989.

Benedetti, Robert P., ed. Flammable and Combustible Liquids Code Handbook, Quincy, MA: National Fire Protection Association, 1990.

Bretherick, L., eds. Hazards in the Chemical Laboratory, London: Royal Society, 1986.

Bretherick, L. Handbook of Reactive Chemical Hazards, London: Butterworths, 1981.

Committee on Hazardous Substances in the Laboratory Assembly of Mathematical and Physical Sciences; National Research Council. Prudent Practices for Handling Chemicals. Washington D.C. National Academy Press, 1981.

Department of Environmental Health and Safety, University of Louisville. Laboratory Safety Manual. January 1989.

Freeman, N.T. And J WhiteHead. Introduction to Safety in the Chemical Laboratory. Orlando. Academic Press Inc., 1982.

Office of Environmental Health and Safety, University of Virginia. Laboratory Survival Manual, 3rd ed., 1993.

Right-to-Know Pocket Guide for School and University Employees. Genium Publishing Corporation, Schenectady, NY 1990

Singer, James; Pesticide Safety: Guidelines for Personnel Protection; Davis, October, 1982.

Supervisors Safety Manual. 6th ed. Chicago: National Safety Council, 1985.

U.S. Department of Health, Education, and Welfare et al. Hazards in the Chemistry Laboratory; Student Manual Sept.1979.

U.S. Department of Health, Education, and Welfare, et al.; NIOSH Health and Safety Guide for Pesticide Formulators; Cincinnati, May, 1977.

U.S. Environmental Protection Agency, Private Pesticide Applicators: Training Manual, February, 1989.

Young Jay A., ed. Improving Safety in the Chemcial Laboratory, A Practical Guide 2nd ed., Wiley & Sons, Inc., New York, 1991.