University of Maryland Center for Environmental Science

Chemical Hygiene Plan

Final Month/Year

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 workplace 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 Chemical Hygiene Plan 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 cannot find an answer, your lab's Safety Officer will try to help you.

Standard Operating Procedures (SOP) will vary from lab to lab. It is the responsibility of the student or staff member to learn the rules that have been established for that particular laboratory, follow these rules, and work in as safe a manner as possible.

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The Lab Commandments

1. Complete Right to Know/Hazard Communication training within 30 days of employment. See your Safety Officer to complete this.
2. Wear appropriate Personal Protection Equipment (PPE) in the lab - lab coat, safety goggles/glasses, gloves, closed toe shoes.
3. Read Safety Data Sheets (SDSs) for all chemicals you will be working with (www.msdsonline.com) and login with ID: **SViewer** and Password **UMCESchemicals**).
4. Be familiar with your lab's Standard Operating Procedures (SOPs) and if you have any questions contact your PI or Safety Officer.
5. Know the location of the safety devices for your lab and how to use them (safety showers, eye washes, laboratory hoods, first aid kits, spill kits)
6. Know the emergency procedures in the event of a chemical exposure, spill, fire, or explosion.
7. Check the lab signage and emergency numbers posted on lab doors.
8. Chemicals must be labeled.
    a. Do not deface original labels on containers.
    b. Secondary containers must be labeled even for short durations to avoid an "unknown" being mistaken as non-hazardous. Secondary containers require four (4) components:
        i. Identifier (name of chemical)
        ii. Signal word (i.e. Danger)
        iii. Hazard Statement (i.e. Flammable Liquid, Corrosive, etc.)
        iv. Pictogram of hazard(s)
9. Store chemicals according to hazards. Segregate incompatible materials - (i.e. oxidizing acids separate from flammable solvents) to prevent inadvertent mixing of chemicals that can react and produce harmful gases/vapors, heat, fire, and explosions. The color codes on labels can be used as a guide for storage groups: Store flammables (red color code) together in flammable cabinet; reactive/physical hazard materials (yellow/orange color code) together; and health hazards materials (blue color code) together. Each storage group should have its own separate storage area.
10. Personal Hygiene
    a. No eating, drinking, chewing gum, or application of cosmetics anywhere in the laboratory.
    b. Do not store food in lab or lab refrigerators or freezers.
    c. Wash hands before leaving the laboratory.
    d. Tie back long hair and loose clothing.

Note: If you must work in the lab alone or after hours let someone know where you are and how long you expect to be there. If you do not return within your time limit they need to check on you. The lab is no place for running, horseplay or practical jokes.

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 UMCES, your lab may require more specialized rules (Standard Operating Procedures) that apply to specific materials and equipment. Please see your Principal Investigator (PI) and/or Safety Officer 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 Principal Investigator (PI), the Safety Officer, and the Safety Data Sheets.
    - 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/safety glasses 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. (UMCES is Smoke Free - Smoking is prohibited in all 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 Safety Officer. 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, make sure you have all containers properly labeled and leave 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 locked out/tagged out 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 (secured and cap screwed on).

E. Emergency Procedures

- In the event of an emergency, remember one number: 911.
- 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 and make sure that contact names and numbers are up to date.
- Be familiar with the location, use and limitations of the following safety devices:
    1. safety shower
    2. eye wash station
    3. protective respiratory gear (respirator use requires a fit test and a medical evaluation)
    4. fume hood
    5. spill cleanup materials
    6. first aid kit
    7. fire alarm
    8. fire extinguisher/fire blanket
- Clean up all small spills immediately. If a large chemical spill occurs, try to contact the Safety Officer (SO). Be prepared to provide information about the magnitude of the spill. If you are unable to reach the Safety Officer (SO), call 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 standby 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 waste at the source by limiting the quantities of materials purchased and used.
- Segregate and prepare chemical wastes for disposal in accordance with the procedures of your lab.
- Dispose of all waste in designated containers. Questions may be directed to the SO.

G. **Miscellaneous**

- Children and pets are not allowed in the laboratory (consult your lab's 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 (OSHA 29 CFR 1910.1200) and State (COMAR 09.12.33) 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 YOU. 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, lab coats, closed toe shoes, and respirators. Each individual laboratory has 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 (Safety Data Sheets and the lab's Standard Operating Procedures) and the best PPE for those activities. Questions about appropriate PPE for your activities can be directed to the Safety Officer.

Informed, responsible individuals can only achieve personal and laboratory safety. This means reading and understanding the Safety Data Sheets (SDS) for the chemicals that you use, discussing any potential hazards with your supervisor, and asking the Safety Officer if you have any further questions concerning proper PPE for your activities in the laboratory.

1. Eye Protection

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 worn. 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. 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

- Eyewear 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 cleaned and disinfected between uses.
- 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.

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 dimethyl mercury, 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.

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 applying 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?

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 Silver Shield or 4H, should be worn under a pair of long-cuffed, unsupported neoprene, nitrile, or similar heavy-duty gloves.

Here are two links to find glove selection information and if you have further ask your Lab Safety Officer. **https://eta-safety.lbl.gov/sites/all/files/VWR%20Chemical%20Resistance%20Gloves%20Chart.pdf**

https://ehs.unc.edu/files/2015/09/Ansell_8thEditionChemicalResistanceGuide.pdf

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 (clogs without perforated tops may be worn with PI/SO permission
- shoes with perforated tops
- high heels
- shoes that expose the top of 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

Proper respiratory protection is required when any work exposes staff to airborne hazards that cannot be controlled in a fume hood. In compliance with OSHA regulations, our "Respiratory Protection Program" says an employee may not wear a respirator in the course of their duties until they have successfully completed the physical examination and respirator fit testing, which is required annually. Employees entered into the "Respiratory Protection Program" will be trained, tested, and provided with respirators appropriate for the hazards involved. An annual physical and fit testing for a respirator must occur before anyone is permitted to wear a respirator. Contact your Safety Officer for more information.

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. The face velocity should be 100 linear feet per minute. The calibration of the fume hoods will be checked on a routine basis by the Safety Officer.

Certain laboratory procedures may require the use of perchloric acid. Perchloric 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. If you need to use perchloric acid, you must consult your lab's Safety Officer 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:

- The face velocity should measure 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. This reduces the efficiency of the hood.
- Clean up spills immediately.
- 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, lab coat, face shield, safety goggles).
- Don't sit down at the hood, it puts your face directly in the fume path.
- Contact the Safety Officer if you suspect that a fume hood is not working properly.
- Do not run cords or tubing over the air foil. They should go underneath the air foil so as not to obstruct flow.

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 chemical vapors, mists, fumes 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:

-airborne concentrations might approach the action level (or permissible exposure limit),
- flammable vapors might approach one tenth of the lower explosion limit
- materials of unknown toxicity are used or generated, or
- 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

The ventilation systems can act as containment if the system provides negative pressure for each lab with respect to the corridors and other labs. These ventilation systems, 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.

The ventilation systems of some of the older buildings do not provide individual lab pressure. Therefore, if a spill occurs is will be circulated throughout the building (other labs, offices, etc.). In this case the Maintenance Department will need to shut off the HVAC systems as soon as possible to prevent the fumes from circulating through the whole building.

3. Chemical Storage Cabinets

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). Chemicals should be stored according to their hazard category (i.e., acids, bases, corrosives, flammables, poisons, reactive material, etc.). Incompatible reagents should not be stored next to each other. (See the chemical incompatibility chart in Appendix II of this manual.)

- 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 flammable cabinets.
- 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 and heavy 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, depending 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" or post the hazard sign for the materials stored". "No Food or Drink Allowed" signage will help remind everyone that no food or drink is allowed in the lab at any time.

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).

Do not 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. Take a copy of the chemical's SDS with you to the emergency room.

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. Know where your safety showers are located. They are operated by grasping the triangular rod and pulling down. 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.

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 (911) from a safe location. Give the Fire Department your name, location of fire, cause of fire.

- 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 notify the Safety officer if they notice any fire extinguishers that are missing, have broken seals, low pressure or have visible damage.
- For fire extinguisher service, requests, training, or any questions contact your lab's Safety Officer.
- 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 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 and PPE.

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 shut off 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

If a central vacuum system is installed in your laboratory, it is important to use a trap on the suction line to prevent liquids from being drawn into the pump.

To activate the vacuum, use the control knob. Be sure to turn the vacuum off when you are finished with it.

Glassware for Vacuum Systems

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. Do not use if defects are noticed.

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

5. Autoclaves/Steam Sterilizers

Autoclaves and steam sterilizers use high pressure and high temperature steam to kill microorganisms and render biohazardous material inactive. Potential risks of using an autoclave are heat and steam burns, hot fluid scalds, injuries to hands and arms from the door, and bodily injury in the event of an explosion.

Always use proper PPE when operating autoclaves such as: heat-insulating gloves, lab coat, safety glasses, and closed toe shoes to help prevent burns and scalds during loading and unloading.

Dos and Don’ts:

- Do not autoclave flammable, reactive, corrosive, toxic (e.g. alcohols, chloroform acetic acid, formalin, or fixed tissues), or radioactive materials.
- Do not autoclave cracked or compromised glassware.
- Do not overload the autoclave. Allow sufficient space between items for steam.
- Do not open the autoclave door during a cycle. If necessary, abort the cycle and wait until the chamber depressurizes.
- Check that plastics are compatible with the autoclave (not all are compatible).
- For liquids, leave caps loose or cover with foil to allow steam penetration and prevent explosion.
- For bagged items, loosely tape or tie closed. Leave an opening for steam to penetrate the bag.

Check list:

- Inspect for spill or debris inside the autoclave and clean prior to use.
- Check door gasket for cracks or bulges.
- Ensure the jacket has reached sufficient pressure to start a cycle.
- Place items in a tub on rack. Never place items directly on the bottom or floor of autoclave.
- For bench top units that do not have inline steam, check and fill the reservoir with deionized water to the fill line (see manufacturer's instructions).
- Close and lock the door before starting a cycle.
- Select the appropriate cycle (e.g. dry heat, sterilize media, sterilize biohazardous waste).
- Check about 20 minutes into the cycle to verify the autoclave has reached sterilization temperature (121 degrees C).
- When the cycle is complete, verify that the temperature has dropped and pressure is zero.
- Wear appropriate PPE.
- Slowly open the door to allow steam to escape gradually. Deep your face away from the door.
- Check the autoclave tape for a color change to see if the time and temperature were attained. If not, the load should be re-autoclaved.
- Allow items to stand in the autoclave for 10 minutes before removing.
- Cautiously remove items. Do not agitate containers as boiling or superheated liquids can explode if moved too quickly.
- Follow the manufacturer's user manual and laboratory SOP for specific instructions.

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. 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 obtained from the Business Office. The Safety 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 the 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 (911).
Direct Pressure -- place sterile pad over the 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 (911).

3. Chemical Burns

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

Skin:

- Remove victim's clothes -- do not 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 (911) without delay.

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

- Call (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 (911) IMMEDIATELY.

Call the **Maryland Poison Control 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

a. Evacuate the area and move the victim into fresh air.
b. Call (911) without delay.
c. 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.
d. 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 regularly to ensure that expended items are replaced. Laboratory supervisors are responsible for maintaining the contents of the first aid kit.

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

C. **CPR & AED**

Personnel who are certified to perform CPR and have been trained to operate the AED (Automated External Defibrillator) should note the location of the nearest AED.

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. It is important to differentiate between an incidental situation and an emergency.

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). Read the SDS for clean-up procedures or contact the Safety Officer.

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. Lab personnel using authorized spill kits can appropriately clean up the release.

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.

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 if your lab has one and leave the room.
- Contact the Safety Officer.
- Call 9-1-1 preferably from a phone outside the lab
- 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 Safety Officer.

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 Safety Officer.

1. Locate the spill kit.

2. Choose the proper personal protective equipment.
    - Always wear gloves and protective eyewear.
    - Use additional PPE such as an apron, coveralls, or boots.
    - Use a fitted respirator (if you are part of the Respiratory Fit Program) and if there is an inhalation hazard above the permissible exposure limit.
3. Confine or contain the spill.

For non-reactive spills:

1. Cover liquid spills with spill kit absorbent and scoop/place into a plastic disposal bag.
2. Sweep solid materials into a dust pan and place in a plastic bag for disposal.
3. Dispose of waste as normal trash as long as substance is non-volatile, non-hazardous.

For reactive or potentially reactive spills:

1. Cover liquid spill with spill kit absorbent and scoop/place into an appropriate disposal container.
2. Avoid spreading hazardous dust.
3. If spilled chemical is a volatile solvent, transfer disposal bag to a hood for evaporation of solvent.
4. Contact Safety Officer for disposal procedures.

Acid Spills

- Apply neutralizer (or sodium bicarbonate) to perimeter of spill or use an absorbent chemical pad found in the spill kit.
- 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 or absorbent pad to a plastic bag, tie shut, fill out a waste label, and place in the fume hood.
- Notify PI and contact the Safety Officer for proper disposal procedures.

Caustic Spills

- Apply neutralizer to perimeter of spill or use an absorbent chemical pad found in the spill kit.
- 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/absorbent pad to a plastic bag, tie shut, fill out a waste label, and place in the fume hood. Notify PI and call the Safety Officer for disposal.

Solvent Spills

- Apply activated charcoal to the perimeter of the spill or use an absorbent chemical pad found in the spill kit.
- 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 PI and call the Safety Officer for disposal.

2. Power Outages

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
- Begin CPR and AED if necessary and you have been trained.

4. Fire Safety

Written Plan

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

Develop a plan which incorporates specific instructions relating to your laboratory. 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.
- Principal Investigators (PIs) 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 indicates 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 in the SDS 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 auto ignition 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 (although UMCES is a smoke free campus).
- 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.
- "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 SDS 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**

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 SDS under Fire and Explosion Data.

Storage & Handling

Explosion hazards.

AVOID:

- allowing picric acid to dry out and form crystals
- mixing flammable chemicals with oxidants
- flammable gas leaks
- heating compressed or liquefied 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 Safety 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 ether, 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)
- 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

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)]

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.

[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.

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** have open flames or hot plates 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 Safety Officer with questions.
- Isolate reactive chemicals from incompatible materials.
- organic materials
- flammable solvents
- corrosives (i.e., nitric and 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 25 ml 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 Safety 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 Dose 50, 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 **TLV** (Threshold Limit Values) or **PEL** (Permissible Exposure Limits). TLVs are compiled by the American Conference of Governmental Industrial Hygienists (ACGIH) based on the 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 SDS 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 (1,1'-biphenyl-4,4'-diamine)

Note: Anyone contemplating work with these carcinogens must contact the Safety Officer 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 housekeeping and maintenance personnel are permitted to clean, 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, and respirators.
- Do not wear used PPE outside of the laboratory.

- Under normal working conditions, no carcinogen should contact your clothing. They are the last line of defense.
- Check the manufacturer's description to be sure that the type of glove, fume hood, 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.
- Principal Investigators 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 and read the SDS.
- 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 Safety 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

"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

UMCES 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 UMCES 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 UMCES units and any satellite locations where hazardous materials are stored or used by an UMCES employee. The following sections identify and explain the required components of the UMCES 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 Safety Data Sheet (SDS). See SDS 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.

UMCES 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 preprinted 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)
9) Chemical name and common name
10) Container size and type (quantity)
11) CAS Number
12) Manufacturer
13) NFPA Rating
14) Work area location
15) Chemical ingredients of listed products
16) Date of addition of chemical to list (if not original)

A list can be exported and printed by going to: www.msdsonline and login with ID: **SViewer** and you Password is **UMCESchemicals**. Find your lab and export and print.

Laboratories are required to produce a similar inventory under the Chemical Hygiene Plan. (Contact the Safety Officer for more information.) The CIL shall be used to assure that SDS's are available for all chemicals used on 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 Safety Officer for inclusion into the master CIL. The Safety Officer will provide copies of the master CIL to the State of Maryland Department of the Environment as required.

Safety Data Sheets (SDS)

Safety Data Sheets (SDS) 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 SDS with the initial shipment of each chemical. The employer for each hazardous chemical listed on the CIL must maintain a copy of the SDS. The PI is responsible for assuring SDSs are available for chemicals listed on each work area's CIL. The Safety Officer can assist supervisors in obtaining copies of SDSs when provided with a completed CIL.

Access to Information

Access to the CIL is available through the Safety Officer to employees, employee representatives, emergency and medical service providers, and regulators upon request and by www.msdsonline and login with ID: **SViewer** and you Password is **UMCESchemicals**. Find your lab and export and print.

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

1. at AL, hard copies are stored in the library;
2. at CBL hard copies are available in individual laboratories;
3. through the UMCP web site: ***http://www.inform.umd.edu/CampusInfo/Departments/EnvirSafety/rtk/msds.html***;
4. 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);

There is a standard 16 section format required for SDS's according to the Global Harmonization Standard.

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 SDS or latest revision date;
3) Identify the hazards (hazard category, health implications, medical conditions affected, acute and chronic effects, routes of entry);

4) First aid procedures;
5) Firefighting 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 employees in the following ways:

1) All employees receive RTK/Hazard Communication information.
2) The Safety Officer provides RTK training. Training is required for all employees. Contact the Safety Officer to arrange for RTK training.

The Safety Officer, if necessary may provide annual retraining.

Trade Secrets

The chemical manufacturers have a right to maintain trade secrets in order to protect individual markets for unique products. However, UMCES reserves the right to contact chemical manufacturers through the 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 SDS.

Outside Contractors

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

contact the Safety Officer or the contractor's site superintendent.

Contractors who need access to the RTK program or SDS's may obtain copies through the 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 SDS'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 Safety Officer for chemical information, job hazard identification or employee training assistance.

Duties and Responsibilities

The UMCES Safety Committee and the Safety Officer shall:

1) Develop and maintain a written RTK program;
2) Provide basic information about the RTK program to all 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 Safety Data Sheets (SDS's) for known hazardous chemicals used in workplaces;
5) Assist employees in accessing SDSs 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.

UMCES Administration shall:

1) Assure that all employees have received the RTK provided by the Safety Officer.
2) Identify sub-units for RTK information compilation; (e.g., the Business Office and Administration, maintenance, housekeeping, and summer interns).

Principal Investigators 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 SDS is for the listed chemicals 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 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)/msdsonline.com inventory current within 30 days; send updates to the 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 receive Employee RTK training offered by the Safety Officer.

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) Complete RTK training.
    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 PI and the Safety Officer so that they may be included on the Chemical Information List/msdsonline.com.
    e) Report any existing health or safety hazard to the PI and L 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 Safety Data Sheets within one day of your 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
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 flouride
Ammonium	Acids, powdered metals, flammable liquids, chlorates, nitrates, sulfur, fine-particulate organic nitrate or combustible 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, naphthalene, 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, combustibles (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, benzaldehyde, sulfuric acid
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds
Sodium	See alkali metals
Sodium Peroxide	Methanol, ethanol, glacial acetic acid, anhydride, benzaldehyde, carbon disulfide, glycerol, ethylene glycol, ethyl acetate, methyl acetate, furfurol
Sulfides	Acids
Sulfuric Acid	Potassium chlorate, potassium perchlorate, potassium permanganate

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

Appendix II
Formaldehyde Policy
Safe Storage, Use and Disposal of Formaldehyde

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 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, UMCES 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 Safety Officer.

Usage Guidelines

1. Use of formaldehyde is restricted to 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 manufacturer's instructions that are provided on formaldehyde containers and the SDS.
3. All large quantities of concentrated formaldehyde and preserved specimens (in alcohol or dilute formaldehyde) may be stored in the Chemical Storage Building or other storage facility. These areas are under the supervision of the Safety Officer.
4. Formaldehyde usage 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. Employees 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 must be **immediately** reported to the 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 Safety Officer.
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. **The person packaging and/or transporting formaldehyde (and any other hazardous material) must have DOT training (49 CFR 172)**. 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 Safety Officer to determine if they should be fitted and approved for respirator use (Respiratory Protection Program). 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 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° F, 85° C (37%), 122° F, 50° 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° 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 handling 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 face piece, 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 face piece or self-contained breathing apparatus (SCBA) with a full face piece. 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. You must complete a medical questionnaire, have a respiratory fit test, and be fitted with an appropriate respirator as per the Respiratory Fit Program.

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 Safety Officer.

For spills > 1 gallon:
Contact Safety Officer.

Appendix III
UMCES 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).
    a. Alert personnel in the immediate vicinity.
    b. Tell them the nature and extent of the emergency.
    c. Close doors, call for assistance.
2. Confine the fire or emergency without endangering yourself.
    a. Shut hood sash if possible.
    b. Close doors to prevent the spread of vapors, gases, or fire.
3. Evacuate the building or hazardous area.
    a. Use the evacuation alarm system.
    b. Follow posted evacuation procedures.
    c. Assemble at designated meeting point.
4. Summon aid from a safe location.
    a. Call 911.
    b. 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 IV

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 Safety Data Sheet (SDS) 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 Safety Officer.

A second principle is to always minimize your actual or potential exposure to a chemical by using appropriate personal protective equipment. The SDS 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, goggles 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 licensed 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 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. Consult procedures for safe storage and disposal of hazardous materials from the appropriate SDS and/or your Safety Officer before initiating any laboratory project involving hazardous or potentially hazardous materials.

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