CHEMICAL HYGIENE PLAN

Building:

Room(s):

Department:

Revised 2009

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I. Emergency Telephone Numbers

CALL IMMEDIATELY FOR ANY EMERGENCY INCLUDING INJURED OR SICK PERSON, CHEMICAL SPILL OR FIRE

Emergency (FIRE - POLICE - RESCUE) - 24 hour #	**911**
UMES Campus Police Department	3300
Maryland Poison Control Center	***1-800-222-1222***
Environmental Health and Safety	
Preston Cottman, Manager	(410) 651-6652
Danna Maloney, Assistant Manager	(410) 621-3040
Human Resources	
Lisa Johnson	(410) 651-7848
Physical Plant Operations and Maintenance	
Work Control Office	(410) 651-7752

Laboratory Supervisor(s): Business-hours # After-hours #

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Laboratory Personnel:

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II. UMES Chemical Hygiene Plan Statement
For Occupational Exposure to Hazardous Chemicals in Laboratories

A. Purpose

This Chemical Hygiene Plan (CHP) was developed by Environmental Health and Safety (EHS) to establish the process for compliance with the Occupational Safety and Health Administration's (OSHA) standard on Occupational Exposure to Hazardous Chemicals in Laboratories (29 CFR 1910.1450).

B. Application and Scope

The University of Maryland Eastern Shore is required to ensure that the necessary work practices, procedures, and policies are implemented to protect employees working in University owned and/or operated laboratories from hazardous chemicals. Hazardous chemical substances, for purposes of this plan, shall be defined as chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes. Chemicals with physical hazards such as flammability and reactivity are also considered hazardous.

The CHP shall be implemented for all laboratory facilities at the University of Maryland Eastern Shore where hazardous chemicals are handled or used under all of the following conditions:

(i) chemical manipulations are performed in containers designed to be easily and safely manipulated by one person;
(ii) multiple chemical procedures or chemicals are used; and
(iii) demonstrably effective laboratory practices and equipment are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

The CHP shall be reviewed and evaluated for its effectiveness at least annually, and updated as necessary.

C. Responsibilities

1. EHS shall:

   (a) Develop, administer, and coordinate implementation of the UMES CHP;
   (b) Perform an annual review and revisions of the CHP as needed;
   (c) Provide consultation, worksite monitoring (sampling), advisory assistance and information concerning use of hazardous materials;
   (e) Investigate, document and report significant chemical exposure or contamination incidents;
   (f) Collect and dispose of hazardous, radioactive and other regulated wastes;
   (g) Conduct and direct periodic laboratory safety audits to determine regulatory compliance, and recommend action to correct conditions generating release of toxic chemicals; and

(h) Monitor the procurement of, use, and disposal of chemicals.

2. Department Chairs and College Deans shall:

(a) Require implementation of the CHP for affected laboratories under their control.

3. Principal Investigators / Laboratory Supervisors/ (PI/LS) shall:

(a) Implement all provisions of the CHP for laboratory facilities under their control;
(b) Maintain a lab-specific CHP for laboratory operations under their control by including the following:

(1) Alphabetized inventory of all hazardous chemical substances,
(2) Written Standard Operating Procedures (SOP) to address safety and health issues associated with work practices and protective equipment in laboratory facilities under their control;
(3) Identification of occurrences or operations that may be encountered by laboratory employees and that require that the LS/PI be advised (prior approval).

(c) Demarcate and indicate on SOP all areas designated for the use of particularly hazardous chemicals (i.e., select carcinogens, reproductive toxins and acute toxins);
(e) Train laboratory workers regarding the specific practices and provisions contained in the laboratory SOP;
(f) Ensure that all lab employees have access to Material Safety Data Sheets (MSDS) for hazardous chemicals that are purchased or otherwise acquired for use in the lab facility;
(g) Ensure that all necessary personal protective equipment and emergency equipment is available, is working properly, and used by lab employees;
(h) Notify the designated UMES contact points when any of the prior notification conditions are anticipated;
(i) Comply with necessary documentation requirements; and
(j) Submit a current copy of the CHP including all required components to EHS.

4. Individual Researchers and Laboratory Users shall:

(a) Adhere to the requirements of the CHP and SOPs;
(b) Complete all safety training requirements and comply with documentation procedures;
(c) Notify the PI/LS if any prior notification situations or occurrences are anticipated; and
(d) Report all workplace injuries, chemical exposure incidents or unsafe conditions to the PI / LS as soon as possible.

III. Prior Approvals

A. In accordance with 29 CFR 1910.1450 (e) (3), the Principal Investigator/Laboratory Supervisor (PI / LS) is responsible for providing institutional notifications as defined below:

1. Any purchase, possession or use of explosive materials (as defined by the US Department of Alcohol, Tobacco & Firearms) must be approved by the University of Maryland, College Park Fire Marshal (301-405-3970). A comprehensive list of explosive materials may be accessed from the ATF Web site at:

   http://www.atf.treas.gov/pub/fire-explo_pub/listofexp.htm

2. Any modification to a chemical fume hood or other laboratory local exhaust system must be reviewed and approved by the Facilities Operations and Maintenance Management (410-651-7752) and/or EHS (Ext. 6652) before it may be used as a means to control exposure to hazardous materials.

3. Any use of hazardous chemicals that may present a hazardous condition due to inadequate ventilation must be reviewed and approved by EHS prior to initiation of the operation.

4. Any research involving animals must be reviewed and approved by the Institutional Animal Care and Use Committee.

5. Any possession or use of radioactive materials or radiation-producing devices must be reviewed and approved by the Radiation Safety Officer (RSO). Additional information may be obtained by calling (410) 651-6652.

6. Any research work involving human subjects must be reviewed and approved by the Institutional Review Board (IRB). Additional information is available at the following Web site:

   http://www.umes.edu/IRB/Default.aspx?id=18988

7. Any purchase, possession or use of etiologic agents must be reviewed and approved by the UMES Institutional Biosafety Committee (IBC).

8. Treatment (e.g., neutralization) or drain disposal of any hazardous waste must be reviewed and approved by EHS. Additional information may be obtained by calling EXT 6652 or EXT 3040.

9. Any use of respirators must be reviewed and approved by the UMES Respiratory Protection Program Administrator. Additional information may be obtained by calling (410) 651-6652.

10. The use of extremely toxic gases must be reviewed and approved by EHS prior to initiation of work. These gases include:

    Arsine and gaseous derivatives
    Chloropicrin in gas mixtures
    Cyanogen chloride

Cyanogen
Diborane
Germane
Hexaethyltetraphosphate
Hydrogen cyanide
Hydrogen selenide
Nitric oxide
Nitrogen dioxide
Nitrogen Tetroxide
Phosgene
Phosphine

B. Laboratory employees are responsible for obtaining approval from the PI/LS if any of the following operations will occur:

1. Laboratory operations that will be left unattended.

2. Modification of any established laboratory procedure.

3. Modification to laboratory chemical inventory.

4. Continuation of any laboratory procedure if unexpected results occur.

5. Use of particularly hazardous materials in locations where no engineering controls (e.g., fume hood) are to be used.

6. Any operation for which employees are not aware of the hazards nor are confident in their ability to be adequately protected.

The PI/LS shall indicate any circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the PI/LS (or designee) before implementation. If no circumstances are identified, the PI/LS shall write "none" in the first provided space. Additional pages may be added as determined necessary by the PI/LS.

1. Circumstance: ____

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Prior approval to be obtained from: ______________________________

2. Circumstance: ____

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Prior approval to be obtained from:______________________________

IV. Standard Operating Procedures (SOPs)

Pursuant to 29 CFR 1910.1450 (e) (1), SOPs shall be incorporated in the on-site copy of the CHP and placed in a designated location within the laboratory for immediate access by employees. SOPs shall be prepared for all routine and repetitive operations. They should describe in clear and precise language the means and methods to be used by laboratory workers to minimize the risk of hazardous exposure while using hazardous chemicals.

The format of all SOPs should be consistent and shall incorporate:

1. Facility name, department and section affected by or using the procedure;

2. Subject;

3. Issue date of the original document or current revision;

4. Any indication that revisions replace an earlier procedure;

5. Signature or initials of the SOP preparer as well as any reviewing authority;

6. Concise instructions for safe and healthful performance of laboratory activities and procedures including the measures that will be used to reduce or prevent employee exposure to hazardous chemicals, including engineering controls, hygiene practices, and the use and maintenance of personal protective equipment.

   Provisions for additional employee protection for work with particularly hazardous substances, including select carcinogens, reproductive toxins, and substances which have a high degree of acute toxicity (see "Identification of Hazardous Materials”).

8. Circumstances under which certain laboratory procedures, operations or activities require prior approval from the PI/LS before implementation (e.g., use of radioactive materials, bench top manipulation of volatile carcinogenic solvents without use of engineering controls, night or weekend work performed alone, reagent substitutions, etc.).

Standard Operating Procedures

(To be attached by Laboratory Supervisor)

V. Chemical Hygiene Practices and Procedures

A. Basic Rules and Procedures for Working with Chemicals

General Safety Principles

Follow these basic guidelines to minimize hazards in the laboratory:

1. Know the hazards associated with the materials being used; read labels before using chemicals, review MSDS, determine the hazards, and exercise appropriate safety precautions.

2. Know the locations and proper use of available protective apparel and safety equipment (fire alarm, fire extinguisher, emergency eye wash and shower stations), and know emergency response procedures.

3. Avoid distracting and startling other workers when they are handling hazardous chemicals.

4. Use equipment and hazardous chemicals only for their intended purposes.

5. Always inspect equipment (e.g. fume hoods, personal protective equipment) for leaks, tears, and other damage before handling a hazardous chemical.

Health and Hygiene

Laboratory workers should observe the following health practices:

1. Avoid direct contact with any hazardous chemical; use protective equipment including safety goggles, face shields, gloves, and other special clothing or footwear as appropriate.

2. Confine long hair and loose clothing, and remove jewelry when in the laboratory. Open-toe shoes, sandals, shorts, etc. are inappropriate attire for the laboratory.

3. Do not use mouth suction to pipette chemicals or to start a siphon; a pipette bulb or an aspirator should be used to provide vacuum.

4. Avoid "routine" exposure to gases, vapors, and aerosols. Do not smell or taste chemicals.

5. Wash well before leaving the laboratory area. Never use solvents for washing the skin.

6. Replace PPE as appropriate.

7. Be familiar with the symptoms of exposure for the chemicals worked with and the necessary precautions to prevent exposure.

Food Handling

Contamination of food, drink, and smoking materials is a potential route for exposure to toxic substances. Food should be stored, handled, and consumed in an area free of hazardous substances. The following statement is the accepted practice regarding food and drink in laboratories:

> There shall be no food, drink, smoking or applying cosmetics in laboratories which have laboratory chemicals present. There shall be no storage of food or beverages in storage areas or laboratory refrigerators. There shall be no handling or consumption of food or beverages using glassware or utensils which are also used for laboratory operations.

Unattended Operations

Frequently, laboratory operations are conducted continuously or overnight. Follow these guidelines in the design of an unattended experiment:

1. Develop a protocol for interruptions in utility services such as electricity, water, and inert gas and other services; provide containment for toxic substances.

2. Arrange for routine inspection of the operation, leave the laboratory lights on, and post a warning notice on the door if hazardous conditions are present.

Working Alone

Avoid working alone whenever possible. If it is necessary, make arrangements with individuals working in separate laboratories to crosscheck periodically. Alternatively, security guards may be asked to check on the laboratory worker. Experiments known to be hazardous should not be undertaken by a worker who is alone in a laboratory.

Chemical Handling and Storage

Chemicals must be handled and stored properly from initial receipt to disposal.

1. Information on proper handling, storage and disposal of hazardous chemicals and the location of MSDSs need to be made available to all laboratory employees prior to the use of the chemical.

2. Always purchase the minimum amount necessary to maintain operations.

3. Do not accept shipments of chemical containers with missing or defaced labels as these violate packaging regulations.

4. Chemicals utilized in the laboratory must be appropriate for the laboratory's ventilation system.

5. Chemicals should not be stored on high shelves, and large bottles should be stored no more than two feet from floor level.

6. Chemicals shall be segregated by compatibility.

7. Use storage trays or secondary containers to minimize the distribution of material should a container break or leak.

8. Chemical storage areas must be labeled as to their contents.

9. Storage of chemicals on the laboratory bench or in other work areas shall be kept to a minimum; storage in fume hoods is prohibited.

10. Laboratory refrigerators are to be used for the storage of chemicals only; food must not be placed in them. Properly label all chemicals stored in the refrigerator (identification of contents and owner, date of acquisition or preparation, and nature of any potential hazard). Flammable liquids must be stored in units that are approved, explosion-proof, or laboratory-safe (NFPA Standards 45 and 56D).

11. Chemicals shall not be stored in corridors, stairways, or hallways; storage must not block access to exits, emergency equipment, or utility controls.

12. Any chemical mixture shall be assumed to be as toxic as its most toxic component; substances of unknown toxicity shall be assumed to be toxic.

13. Chemicals stored in the laboratory shall be inventoried at least annually. Old or unneeded chemicals must be disposed of or recycled. On termination, transfer, graduation, or such of any laboratory personnel, the laboratory custodian should arrange for transfer through EHS of all hazardous materials those persons have on hand.

Stockroom Guidelines

1. The storage space will depend on the size of the area, the quantities handled, and the nature of the hazards associated with the chemicals.

2. Stored chemicals shall be examined at periodic intervals (at least quarterly). Chemicals that have expired or have deteriorated, have questionable labels, are leaking, have corroded caps, or have developed any other problem should be disposed of according to procedures outlined in the UMES Hazardous & Regulated Waste Management Manual. A first-in, first-out system of stock keeping should be used. Shelving should have a retaining stock cord or raised edge to prevent chemicals from sliding off the edge and falling.

3. Stockrooms should usually be within or close to the areas served. Stockrooms should be conveniently located and open during normal working hours so that laboratory workers need not store excessive quantities of chemicals in their laboratories.

4. Stockrooms should not be used as preparation areas because of the possibility that an accident will occur and thereby unnecessarily contaminate a large quantity of materials. Preparation and repackaging should be performed in separate area.

5. Procedures must be established for the operation of any stockroom that place responsibility for its safety and inventory control in the hands of one person. At UMES, this individual is the custodian of the stockroom, who must be readily available.

6. Stockrooms should be well ventilated. If storage of opened containers is permitted, extra local exhaust ventilation and the use of outside storage containers or spill trays are necessary.

7. Store bulk flammable liquids in a cut-off room (separated from other areas by fire-rated construction), at grade level, with one exterior wall. The room should contain walls and ceilings constructed of materials having at least a 2-hour fire resistance, self closing Class B fire doors, mechanical ventilation controlled by a switch outside the door, and explosion-proof lightning and switches.

8. To dispense chemicals from sealed drums, remove the bung and replace with an approved pressure and vacuum relief vent to protect against internal pressure build up in the event of fire or if the drum might be exposed to direct sunlight.

Drum Storage

If possible, drums should be stored on metal racks placed such that the end bung openings are toward an aisle and the side bung openings are on top. The drums, as well as the racks, should be grounded with a minimum length of American wire gage 10 wires. Because effective grounding requires metal-to-metal contact; all dirt, paint, and corrosion must be removed from the contact areas. Spring-type battery clamps and a minimally sized conductor (e.g., American wire gage 8 or 10) are satisfactory. It is also necessary to provide bonding to metal receiving containers to prevent accumulation of static electricity (which will discharge to the ground, creating a spark that could ignite the flammable vapors). Drip pans that have flame arrestors should be installed or placed under faucets.

Dispensing from drums is usually done by one of two methods. The first is gravity based through drum faucets that are self-closing and require constant hand pressure for operation. Faucets of plastic construction are generally not acceptable due to chemical reaction on with the plastic materials. The safer method is to use an approved hand-operated rotary transfer pump. Such pumps have metering options and permit immediate cutoff control to prevent overflow and spillage, can be reversed to siphon off excess liquid in case of overfilling, and can be equipped with drip returns so that any excess liquid can be returned to the drum.

Housekeeping

Safety follows from good housekeeping practices. The following applies to laboratory areas as it pertains to housekeeping:

1. Keep work areas clean and uncluttered, and properly label and store chemicals and equipment; clean up should follow the completion of any operation or at the end of each day.

2. Clean spills and dispose of wastes immediately.

3. Floors should be cleaned regularly to remove accumulated dust, chromatography absorbents, and other assorted materials that pose respiratory hazards.

4. Never block stairways, hallways, access to exits, emergency equipment, or utility controls.

5. Inspect and maintain equipment regularly, and plan for the possibility and consequence of equipment failure. Maintenance plans should include a procedure to ensure that a device that is out of service cannot be restarted

6. The laboratory supervisor should provide for regular formal safety and housekeeping inspections (at least quarterly for areas with frequent personnel changes and semiannually for other laboratories) in addition to Conditional informal inspections.

Transporting Chemicals

The method of transport of chemicals between storage areas and laboratories must reflect the potential danger posed by the specific substance.

1. When chemicals are hand carried, use a specially designed bottle carrier or a leak resistant, unbreakable secondary container to protect against breakage and spillage.

2. When chemicals are transported on a wheeled cart, the cart should be stable under the load and have wheels large enough to negotiate uneven surfaces (such as expansion joints and floor drain depressions) without tipping or stopping suddenly. The cart should also have high edges to contain leaks or spills.

3. To avoid exposure to persons on passenger elevators, if possible, transport on freight-only elevators.

4. Provisions for the safe transport of small quantities of flammable liquids include (a) the use of rugged pressure-resistant, non-venting containers, (b) storage during transport in a well-ventilated vehicle, and (c) elimination of potential ignition sources.

Storage and Disposal of Hazardous Waste

1. The Hazardous and Regulated Waste Management Manual specifies how regulated waste is collected, segregated, stored, and transported.

2. Waste should be removed from laboratories to a central waste storage area at least once per week and from the central waste storage area at regular intervals.

3. Indiscriminate disposal by pouring waste chemicals down the drain or adding them to mixed refuse for landfill burial is illegal.

4. Do not use fume hoods must as a means of disposal for chemicals, especially volatile chemicals. Disposal by recycling or chemical decontamination should be used when possible.

B. Laboratory Safe Handling and Storage Requirements

Identification of Hazardous Materials

The following apply with respect to labels and MSDS:

1. The PI/LS shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced; labels must contain information on the identity of the chemical(s) and the associated hazards with use of the chemical.

2. PIs/LSs shall maintain any MSDS that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees at all times.

Laboratory-Developed Chemicals

The following apply to chemical substances developed in the laboratory:

1. If the composition is known and is produced exclusively for the laboratory's use, the PI must determine associated hazards, if any, and provide appropriate training to protect employees.

2. If the chemical is a product or by-product with unknown composition, the PI must assume the substance is hazardous and comply with the requirements of the CHP.

3. If the chemical is produced for use outside of the laboratory, the PI must prepare an appropriate MSDS in accordance with the OSHA Hazard Communication Standard.

Information and Training

All employees shall be provided with information and training regarding the hazards of the chemicals in their work area. Employees shall be informed of:

1. The contents of the OSHA standard and its appendices;

2. The location and availability of the CHP;

3. The permissible exposure limits (PELs) for OSHA regulated substances or recommended exposure limits if no PEL is listed;

4. The methods and observations used to detect the presence or release of a hazardous chemical;

5. The physical and health hazards of chemicals in the work area;

6. The measures employees can take to protect themselves from chemical hazards, including the location and proper use of protective apparel and equipment, and specific procedures (SOPs) to be used;

7. Emergency procedures including available first aid instruction, and the proper use of emergency equipment;

8. Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and;

9. The location of known reference material on the hazards, safe handling, storage, and disposal of chemicals found in the laboratory.

Any staff member who does not understand a policy or procedure should consult the LS/PI for clarification.

Information concerning the health effects of chemical substances can be located in the following reference sources:

- Material Safety Data Sheets (MSDS) are available through the vendor, manufacturer, or distributor. (A MSDS must be provided at the time of initial purchase by the vendor, manufacturer or distributor without charge. A nominal fee may be assessed for additional copies.)

- National Institute of Occupational Safety and Health (NIOSH) Pocket Guide of Chemical Hazards: http://www.cdc.gov/niosh/npg/default.html

- National Toxicology Program: http://ntp.niehs.nih.gov/

- International Agency for Research on Cancer: http://www.iarc.fr/

Certain OSHA-regulated substances (Appendix B) are subject to specific occupational safety and health standards. These standards are not replaced by the Occupational Exposure to Hazardous Chemicals in Laboratories standard. Users of these materials are expected to adhere to the provisions of all applicable substance-specific standards if employee exposure routinely exceeds the OSHA-mandated permissible exposure limit (or Action Level, if specified). Copies of these standards may be obtained from EHS or through the OSHA web site at www.osha.gov.

Provisions for Particularly Hazardous Substances

The OSHA Laboratory Standard requires special precautions for additional employee protection for the use of select carcinogens, reproductive toxins, chemicals with a high degree of acute toxicity, and unknowns. Select carcinogens are any substance which meets one of the following criteria:

- Regulated by OSHA as a carcinogen;
- Listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (latest edition);
- Listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer (IARC) Monographs (latest edition); or

- Listed in either Group 2A or 2B by the IARC, or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with criteria specified in the OSHA laboratory standard.

The standard requires that employees' exposures do not exceed the Permissible Exposure Limits (PEL), which represent Time Weighted Averages (TWAs) in parts per million (ppm) or milligrams per substance per cubic meter of air (mg/m^3). The American Conference of Governmental Industrial Hygienists (ACGIH) has established Threshold Limit Values (TLVs), which are TWA values similar to PELs. To keep employee exposures as low as reasonably achievable, employee exposure must not exceed the lowest exposure limit (PEL or TLV). Exposure limits can be found on the chemical's MSDS or by contacting EHS.

The following general hygiene standards shall be observed when using select carcinogens, reproductive toxins, chemicals with a high acute toxicity, and unknowns:

1. Use and store materials only in established, designated areas in a restricted access hood, glove box, or portion of the lab designated only for those materials; storage areas shall have posted warning signs with limited access, and be adequately ventilated.

2. Use proper containment devices for the protocol and chemical(s) being used which may result in the generation of aerosols or vapors; trap released vapors to prevent their discharge with fume hood exhaust.

3. Store breakable containers in secondary chemical-resistant trays; work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic-backed paper.

4. Follow the established procedures in the UMES Hazardous and Regulated Waste Management Manual for removal of contaminated waste.

5. Follow decontamination procedures prior to leaving the designated area:

    a. On leaving the area, remove personal protective apparel and thoroughly wash hands, forearms, face, and neck.
    b. Thoroughly decontaminate or dispose of contaminated clothing or shoes; if possible, chemically decontaminate by chemical conversion to a less toxic product.
    c. Decontaminate vacuum pumps or other contaminated equipment, including glassware, before removing them from the designated area. Decontaminate the designated area before normal work is resumed.
    d. Use a wet mop or a vacuum cleaner equipped with a HEPA filter to decontaminate surfaces. DO NOT DRY SWEEP SPILLED POWDERS.
    e. Protect vacuum pumps against contamination with traps and/or appropriate filters and vent effluent into the hood.

Exposure Monitoring

Exposure monitoring must be provided under the following circumstances:

1. Initial monitoring when there is reason to believe that employee exposure levels routinely exceed ½ the PEL.

2. Periodic monitoring when initial monitoring reveals an exposure over ½ the PEL.

Physical Hazards

Cold Traps and Cryogenic Hazards

Cryogenic liquids such as oxygen, nitrogen, argon, helium, and hydrogen are substances that are normally in the gaseous state but are cooled to extremely low temperatures so that they are liquids. Hazards associated with cryogens are fire, pressure, weakening of materials, and skin or eye burns or freezing upon contact with the liquid. The following precautions are necessary:

1. Equipment must be kept clean.

2. Mixtures of gases or fluids must be strictly controlled to prevent formation of flammable or explosive mixtures.

3. Always wear safety glasses with side shields or goggles; wear a full protective face shield, an impervious apron or coat, cuffless trousers, and high topped shoes where chemical splash or spray is possible. Gloves should be impervious and sufficiently large to be readily thrown off should a cryogen spill occur. Pot holders can also be used.

4. Cryogenic containers and systems should have pressure relief mechanisms.

5. Cryogenic containers should be made from materials such as austenitic stainless steels, copper, and certain aluminum alloys that are capable of withstanding extremely low temperatures.

6. Storage of radioactive, toxic, or infectious agents must be in plastic cryogenic storage ampoules as glass ampoules can explode if not sealed properly.

7. Appropriate dry gloves should be used when handling dry ice, which should be added slowly to the liquid portion of the cooling bath to avoid foaming over. Workers should avoid lowering their head into a dry ice chest: carbon dioxide is heavier than air, and suffocation can result.

Compressed Gases

Cylinders of compressed gases pose mechanical, physical and/or health hazards, depending on the compressed gas in the cylinder.

1. Cylinders must be labeled and grouped by type of gas (i.e. flammable, toxic, or corrosive).

2. Cylinders with regulators must be individually secured in an upright position to a wall or bench top. Cylinders with valve protection caps may be chained in groups.

3. Move cylinders using an appropriate cart and ensure the valve protection cap is secured.

4. Store compressed gas cylinders in well-ventilated, dry areas away from sources of ignition or exposure to corrosive chemicals or vapors, and from heavy objects. Store empty cylinders separate from full cylinders.

5. Never bleed a cylinder completely empty; leave slight pressure to keep contaminants out.

6. Do not lubricate an oxygen regulator or use a fuel gas regulator on an oxygen cylinder. Use an oxygen approved regulator. Wrenches used on oxygen cylinders should be made of non-ferrous metal.

7. Wear goggles or safety glasses with side shields when handling compressed gases.

8. Always use appropriate gauges, fittings, and materials compatible with the particular gas being handled.

9. Do not subject cylinders to rough handling or abuse. Such misuse can seriously weaken the cylinder and render it unfit for further use or transform it into a rocket having sufficient thrust to drive it through masonry walls. Handle only one cylinder at a time.

Corrosives

Corrosives can react with the skin, causing burns similar to thermal burns, and can react with metal causing deterioration of the metal's surface.

1. Corrosives and equipment used for storage and processing of corrosives must be corrosion resistant.

2. A face-shield, rubber apron, and/or rubber boots may be necessary in addition to eye protection and appropriate gloves when handling corrosive material.

3. Never add water to acid. When mixing concentrated acids with water, add the acid slowly to water.

4. An eyewash and safety shower must be readily accessible (within 10 seconds) to areas where corrosives are used and stored.

Flammability Hazards

The National Fire Protection Agency (NFPA) categorizes flammable and combustible liquids as listed in the following table.

Flammable	Flash Point	Boiling Point
Class IA	< 73 deg F (22.8 deg C)	< 100 deg F (37.8 deg C)
Class IB	< 73 deg F (22.8 deg C)	100 deg F (37.8 deg C)
Class IC	73 deg F (22.8 deg C)	
Combustible		
Class II	100 deg F (37.8 deg C) & <140 deg F (60 deg C)	
Class IIA	140 deg F (60 deg C) & <200 deg F (93 deg C)	
Class IIIB	200 deg F (93 deg C)	

For handling flammable/combustible materials, observe the following guidelines:

1. Do not store over 1 liter of flammables in refrigerators or freezers.

2. Store quantities greater than 1 liter in NFPA approved flammable liquid containers; store quantities 10 gallons or greater in flammable storage cabinets, in an area isolated from ignition sources.

3. Do not use an open flame to heat a flammable liquid or to carry out a distillation under reduced pressure; use an open flame only when necessary and extinguish it when it is no longer actually needed.

4. Before lighting a flame, remove all flammable substances from the immediate area. Check all containers of flammable materials in the area to ensure that they are tightly closed.

5. When volatile flammable materials may be present, use only non-sparking electrical equipment.

Table I. Container Size Limitations for Flammable and Combustible Liquids

Container Type	Class IA	Class IB	Class IC	Class II	Class IIA
	Liters / Gallons				
Glass	0.5 / 0.12	1 / 0.25	4 / 1	4 / 1	4 / 1
Metal (Other than DOT drums)	4 / 1	20 / 5	20 / 5	20 / 5	20 / 5
Safety Can	7.5 / 2	20 / 5	20 / 5	20 / 5	20 / 5
Metal Drum (DOT Specific)	225 / 60	225 / 60	225 / 60	225 / 60	225 / 60
Approved portable tanks	2500 / 600	2500 / 600	2500 / 600	2500 / 600	2500 / 600

OSHA limitation; NFPA Nos. 30 and 45 allow 20 liters (5 gal).
Maximum size permitted in a laboratory for Class I materials is 20 liters (5 gal); drum size is permitted only in an inside storage room (OSHA) 1910.106 and NFPA No. 30
Permitted only outside of buildings.
Only minimum working quantities of toxic materials should be present in the work area.

Storage vessels containing such substances should carry a label such as the following: CAUTION: HIGH CHRONIC TOXICITY or CANCER-SUSPECT AGENT.

<u>Glassware</u>

Accidents involving glassware are a leading cause of laboratory injuries.

1. Careful handling and storage procedures should be used to avoid damaging glassware. Damaged items should be discarded or repaired.

2. Adequate hand protection should be used when inserting glass tubing into rubber stoppers or corks or when placing rubber tubing on glass hose connections. Tubing should be fire polished or rounded and lubricated, and hands should be held close together to limit movement of glass should fracture occur. The use of plastic or metal connectors should be considered.

3. Glass-blowing operations should not be attempted unless proper annealing facilities are available.

4. Vacuum jacketed glass apparatus should be handled with extreme care to prevent implosions. Equipment such as Dewar flasks should be taped or shielded. Only glassware designed for vacuum work should be used for that purpose.

5. Hand protection should be used when picking up broken glass. (Small pieces should be swept up with a brush into a dustpan.)

6. Proper instruction should be provided in the use of glass equipment designed for specialized tasks, which can represent unusual risks for the first-time user. (For example, separator funnels containing volatile solvents can develop considerable pressure during use).

<u>Incompatible Chemicals</u>

The term "incompatible chemicals" refers to chemicals that can react with other

- Violently
- With evolution of substantial heat
- To produce flammable products or
- To produce toxic products

The EPA ECRA regulations specify that incompatible chemicals must not be placed in the same lab pack for landfill disposal, and the DOT regulations have a similar prescription on packing incompatible chemicals for transport. Incompatible chemicals should always be handled, stored, and packed so that they cannot accidentally come into contact with each other.

Guidelines for the segregation of common laboratory chemicals that are incompatible are presented in Tables II and III. Table II contains general classes of compounds that should be kept separated; chemicals in Column A should be kept separate from those in Column B. Table III in Appendix III lists specific compounds that can pose reactivity hazards.

Table II. General Classes of Incompatible Chemicals

A	B
Acids	Bases and Metals
*Oxidizing Agents**	*Reducing Agents**
Chlorates	Ammonia (anhydrous and aqueous)
Chromium trioxide	Carbon
Dichromate	Metals
Halogens	Metal hydrides
Halogenating Agents	Nitrites
Hydrogen peroxide	Organic compounds
Nitric Acid	Phosphorus
Nitrates	Silicon
Perchlorates	Sulfur
Peroxides	
Permanganates	
Persulfates	

*The list of chemical agents in Table II is illustrative of common laboratory chemicals and is not intended to be exhaustive.

Light-Sensitive Chemicals

These materials degrade in the presence of light, forming new possibly hazardous compounds, or resulting in conditions such as pressure build-up inside a container. Examples include chloroform, tetrahydrofuran, ketones, and anhydrides. Store light-sensitive materials in cool, dark places in amber colored bottles or other containers which reduce or eliminate penetration of light.

Peroxide-Forming Chemicals

These materials undergo auto-oxidation (a reaction with oxygen in air) to form peroxides which can explode with impact, heat, or friction. These chemicals may be packaged in an air atmosphere and peroxides may form even though the container has not been opened.

1. Pyrophoric chemicals must be stored in tightly closed containers under an inert atmosphere (or, for some, an inert liquid), and all transfers and manipulations of them must be carried out under an inert atmosphere or liquid.

2. Date all peroxidiables upon receipt and upon opening. After the recommended disposal date, test the chemical for peroxides or dispose of them properly.

3. Do not open any containers which have obvious solid formation around the lid.

4. Addition of an appropriate inhibitor to quench the formation of peroxides is recommended.

5. Follow the same basic handling procedures as for flammable materials.

6. Some types of compounds form peroxides that are treacherously and violently explosive in concentrated solution or as solids. Accordingly, peroxide containing liquids should never be evaporated to dryness.

7. Peroxide formation can also occur in many polymerizable unsaturated compounds, and these peroxides can initiate a runaway, sometimes explosive polymerization reaction. .

Table IV (Appendix III) lists common laboratory chemicals that are prone to form peroxides. Table V (Appendix III) provides a list of structural characteristics in organic compounds that can peroxidize and some common inorganic materials that form peroxides.

Pyrophoric Chemicals

These materials ignite spontaneously upon contact with air. Often the flame is invisible. Pyrophoric chemicals need to be used and stored in inert environments. Appendix III includes a list of pyrophoric chemicals.

Sodium Azide

Sodium azide, a bactericide widely used in medical research, represents a risk due to the possible formation of explosive metallic azides when sodium azide reacts with copper, lead and other heavy metals in waste water system piping. The formation of metallic azides is thought to result when water combines with azide leading to the formation of hydrazoic acid (HN^3). Hydrazoic acid, itself an explosive, is then able to react with lead or copper to form highly explosive metallic azides.

Several explosions have been documented where sodium azide solutions had been used in laboratory equipment or discarded in waste water piping systems. These explosions usually occurred when service personnel applied heat or friction to azide contaminated metallic surfaces.

To prevent azide formation, the following actions should be considered:

1. Substitution- Several commercial antibacterial products are available which do not use sodium azide (Clear-Bath, Roccal, etc).

2. Flushing of Drains- Always flush drains or metallic equipment thoroughly after discarding sodium azide solutions. This may not eliminate the formation of azide compounds, but will reduce their amount.

3. Storage- Sodium azide solutions should not be stored in cabinets or refrigerators with exposed copper or lead parts.

4. Decontamination- Decontamination should be performed prior to repairing or discarding sodium azide contaminated metallic components or equipment. The decontamination process is as follows:

    a. Make a dilute (2-10%) solution of NaOH.

b. Pour the NaOH solutions into the drain or equipment so as to flush all contaminated surfaces.Treated materials should remain undisturbed for at least 16 hours. Repeat two more times at intervals of one week.

5. Labeling- All drain lines or metallic equipment that are regularly exposed to sodium azide solutions should be labeled indicating the existence of potential explosion hazard.

<u>Systems Under Pressure</u>

Reactions should never be carried out in, nor heat applied to, an apparatus that is a closed system unless it is designed and tested to withstand pressure. Pressurized apparatus should have an appropriate relief device. If the reaction cannot be opened directly to the air, an inert gas purge and bubbler system should be used to avoid pressure buildup.

<u>Unstable Chemicals</u>

Chemicals that have potential for producing a violet explosion when subjected to *shock or friction* are unstable chemicals. Some common classes of unstable chemicals are listed in Appendix III.

<u>Water-Reactive Chemicals</u>

Water-reactive chemicals react with water to evolve heat and flammable or explosive gases often resulting in a fire or explosion. Storage for water-sensitive chemicals must prevent their accidental contact with water or water vapor (i.e. without automatic sprinkler systems), and should be of fire- resistant construction. Other combustible materials should not be stored in the same area. Some common water-reactive chemicals are listed in Appendix III.

Health Hazards

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

Radioactive Material Hazards

Use of radioactive materials at UMES is strictly controlled. If you plan to use radioactive materials or radiation-producing devices, contact the Radiation Safety Office at 410-651-6652. Any research involving radioactive materials must be reviewed and approved by the Radiation Safety Committee.

Biological Material Hazards

Use of certain biological materials at UMES is strictly controlled. Research involving biological materials must be reviewed and approved by, and registered with the Institutional Biosafety Committee.

C. Laboratory Facility Requirements

Signs and Labels

Labels and warning signs shall be posted to alert personnel to potentially hazardous conditions and to identify hazardous chemical use and storage areas, safety facilities (showers, eyewash stations), emergency equipment (first aid kit, chemical spill kit, fire extinguishers), and emergency exits.

Facilities containing the following hazards must have warning signs posted with emergency contact numbers, information on the hazards in the laboratory, and the proper precautions to take upon entrance):

- Known carcinogens
- Lasers
- Strong Magnetic fields
- HIV and HBV research laboratories and production facilities
- Biological agents that require Biosafety Level 2 or higher
- Radioactive materials or sealed radioactive sources
- Other chemical hazards with consultation from EHS

Control Measures

OSHA requires control measures when the following circumstances are met:

1. whenever employees use hazardous chemicals,
2. whenever employee exposures exceed ½ the PEL and/or the TLV,
3. Upon addition of new chemicals or changes in procedures, or
4. Other situations should be dealt with on a case-by-case basis. Consult EHS for assistance in establishing control measures.

The PI or lab supervisor must implement control measures to reduce employee exposure to hazardous chemicals. The three types of control measures are:

1. Administrative Controls: methods of controlling employee exposures to contaminants by job rotation, work assignment or time periods away from the contaminant. Examples include Standard Operating Procedures, Chemical Hygiene Plans and Safety Manuals.

2. Engineering Controls: methods of controlling employee exposures by modifying the source or reducing the quantity of contaminants released into the work environment. Examples include fume hoods and biosafety cabinets.

3. Personal Protective Equipment: personal safety equipment designed for secondary employee protection from hazardous chemicals. Examples include gloves and lab coats.

Note: OSHA law regarding air contaminants states that engineering controls and administrative controls shall first be determined and implemented when feasible. When such controls are not feasible to achieve full compliance, protective equipment or any other protective measures shall be used to keep the exposure of employees to air contaminants within the limits prescribed in the rule.

Follow these steps for controlling exposures to hazardous chemicals:

1. Determine the source of exposure.
2. Determine the path the contaminant follows to reach the employee; determine the route(s) of exposure (i.e. inhalation, absorption, injection, ingestion, or a combination).
3. Determine the employee's work pattern and use of personal protective equipment.
4. Change one or more of the above pathways to reduce or eliminate exposure.
5. Substitute less harmful chemicals for more harmful chemicals whenever possible.
6. Change or alter processes to minimize exposure.
7. Isolate or enclose a process or work operation to reduce the number of employees exposed (for example, use a fume hood).
8. Use wet methods to reduce the generation of dust.
9. Use local exhaust ventilation (hoods) at point of generation or dispersion of contaminants and use dilution (general) ventilation to reduce air contaminants.
10. Practice good housekeeping procedures to reduce unnecessary exposures.
11. Use training and education as primary administrative controls for reducing exposures.
12. Use special control methods such as shielding and continuous monitoring devices to control exposures in special situations.

Personal Protective Equipment

OSHA has adopted the American National Standards Institute (ANSI) consensus standards for eye protection All eye protective devices must be stamped with "Z87" by the manufacturer if they meet ANSI standards. If the eye protection is not marked, it may not be the most effective protection available.

<u>Eye Protection</u>

Eye protection must be made available for all personnel and any visitors present in laboratories where chemicals are stored or handled. No one should enter any laboratory without appropriate eye protection. The following types of eye protection are recommended for use in the laboratory by ANSI:

- Safety glasses with side shields offer minimal protection against flying fragments, chips, particles, sand and dirt. When a splash hazard exists, other protective eye equipment need to be worn.

- Safety goggles (impact goggles) offer adequate protection against flying particles. These need to be worn when working with glassware under reduced or elevated pressure or with drill presses or other similar conditions.

- Chemical splash goggles (acid goggles) have indirect venting for splash proof sides, which provide adequate protection against splashes. Chemical splash goggles offer the best eye protection from chemical splashes. Impact goggles should not be worn when danger of a splash exists.

- Faceshields protect the face and neck from flying particles and splashes. Always wear additional eye protection under faceshields. Ultraviolet light face shields or UV light-restricting safety glasses should be worn when working around UV light sources.

Contact Lenses

Contact lenses should not be worn in a laboratory. Gases and vapors can be concentrated under such lenses and cause permanent eye damage. It is often nearly impossible to remove contact lens to irrigate the eye in the event of chemical splash due to involuntary spasm of the eyelid. Persons attempting to irrigate the eyes of an unconscious victim may not be aware of the presence of contact lenses, thus reducing the effectiveness of such treatment. Soft lenses can absorb solvent vapors even through face shields and, as a result, adhere to the eye.

Safety Spectacles

Ordinary prescription glasses do not provide adequate protection from injury to the eyes. The minimum acceptable eye protection requires the use of hardened-glass or plastic safety spectacles with a minimum lens thickness of 3mm, impact resistance requirements, passage of a flammability test, and lens retaining frames.

Protection of Skin and Body

Skin and body protection involves the use of protective clothing to protect individuals from chemical exposure. The basic and most effective forms of protection are gloves and lab coats.

Specialized impervious protective equipment must be utilized when working with extremely hazardous substances (strong acids and acid gases, organic chemicals and strong oxidizing agents, carcinogens, and mutagens). Examples include: appropriate gloves, aprons, coveralls, boots, protective suits, shoe covers, and gauntlets. Such apparel must be either washable or disposable in nature.

Gloves should be worn whenever it is necessary to handle corrosive materials, rough or sharp edged objects, very hot or very cold materials, or whenever protection is needed against accidental exposure to chemicals. Gloves should not be worn around moving machinery. Table VI (Appendix IV) lists the resistance of different glove materials to chemicals commonly used in the laboratory.

Respirators

The use of respirators is only allowed where engineering controls are being installed or when they are not feasible. Any individual that uses a respirator as part of his or her work at the University must be enrolled in the Respiratory Protection Program. Prior to using a respirator for the first time or for a new activity, employees must receive a medical exam, attend an EHS respiratory training session, and be fit tested. Please contact the EHS for a copy of the University Respiratory Protection Program. It is also available on the EHS web page.

Safety Equipment

All laboratories in which chemicals are used should have available and operable fire extinguishers, safety showers, and eyewash fountains, as well as laboratory hoods and laboratory sinks (which can be considered part of the safety equipment of the laboratory).

OSHA has adopted the American National Standards Institute (ANSI) consensus standards for emergency shower and eyewash facilities.

Safety Showers

Safety showers provide an immediate water drench of an affected person. The EHS recommends the following ANSI standards for location, design and maintenance of safety showers:

- Showers shall be located within 25 feet of areas where chemicals with a pH of 2.0 or 12.5 are used.
- Showers shall be located within 100 feet of areas where chemicals with a pH of > 2 and < 4 or 9 and < 12.5 are used.
- The location of the shower should be clearly marked, well lighted and free from obstacles, closed doorways or turns.
- Safety showers are checked and flushed annually by EHS.

Eye Wash Facilities

Eye wash facilities should be within 25 feet or 10 seconds travel of areas where injurious or corrosive chemicals are used or stored.

- Optimally, those affected must have both hands free to hold open the eye to ensure an effective wash behind the lids. This means providing eye wash facilities that are operated by a quick release system and simultaneously drench both eyes.
- Eye wash facilities must provide the minimum of a 15 minute water supply at no less than 0.4 gallons per minute.
- Eye wash facilities must not exceed 25 pounds per square inch (PSI).
- Eye wash facilities need to be flushed out for five minutes at a time, once per week.

Guarding For Safety

All mechanical equipment should be adequately furnished with guards that prevent access to electrical connections or moving parts (such as the belts and pulleys of a vacuum pump). Each laboratory worker should inspect equipment before using it to ensure that the guards are in place and functioning.

Shielding For Safety

Safety shielding should be used for any operation having the potential for explosion such as (a) whenever a reaction is attempted for the first time (small quantities of reactants should be used to minimize hazards), (b) whenever a familiar reaction is carried out or a larger than usual scale (e.g., 5-10 times more material), and (c) whenever operations are carried out under non-ambient conditions. Shields must be placed so that all personnel in the area are protected from hazard.

Ventilation Controls

Ventilation controls are those controls intended to minimize employee exposure to hazardous chemicals by removing air contaminants from the work site. There are two main types of ventilation controls:

1. General (Dilution) Exhaust: a room or building-wide system which brings in air from outside and ventilates within. Laboratory air must be continually replaced, preventing the increase of air concentration of toxic substances during the work day. General exhaust systems are not recommended for the use of most hazardous chemicals.

2. Local Exhaust: a ventilated, enclosed work space intended to capture, contain and exhaust harmful or dangerous fumes, vapors and particulate matter generated by procedures conducted with hazardous chemicals (i.e. fume hood).

To determine ventilation requirements, assess the MSDS. Some MSDS terminology, as listed below, may indicate a need for special ventilation considerations beyond general exhaust ventilation: “Use with adequate ventilation,” “Avoid vapor inhalation,” “Use in a fume hood,” “Provide local exhaust ventilation.”

<u>Proper Use of Fume Hoods</u>

Fume hoods must be used properly to be effective. For use of hazardous chemicals warranting local ventilation controls, the following guidelines should be observed:

1. Conduct all operations which may generate air contaminants at or above the appropriate PEL or TLV inside a fume hood.

2. Keep all apparatus at least 6 inches back from the face of the hood and keep the slots in the hood baffle free of obstruction by apparatus or containers. Large equipment should be elevated at least two inches off the base of the fume hood, to allow for the passage of air underneath the apparatus.

3. Do not use the hood as a waste disposal mechanism.

4. Minimize storage of chemicals or apparatus in the hood.
5. Keep the hood sash closed at all times except when the hood is in use.
6. Minimize foot traffic and other forms of potential air disturbances past the face of the hood.
7. Do not have sources of ignition inside the hood when flammable liquids or gases are present.
8. Use the sash as a safety shield when boiling liquids or conducting an experiment with reactive chemicals.
9. Periodically check the air flow in the hood using a continuous monitoring device or another source of visible air flow indicator. If air flow has changed, contact EHS for an inspection.
10. Never work with hazardous chemicals if the required ventilation system is not working.
11. A laboratory hood with 2.5 linear feet of hood space per person should be provided for every 2 workers if they spend most of their time working with chemicals.
12. Fume hoods require annual inspection. The certification date must be posted on the fume hood, and the hood sash should be set at the proper position for optimum hood performance. In general, the sash height should be set at a level where the operator is shielded to some degree from any explosions or violent reactions which could occur and where optimum air flow dynamics are achieved.

D. Emergency and Medical Procedures

Spills and Accidents

Spill Response – Major Spills

Releases of hazardous substances that pose a significant threat to health or safety, or that require an emergency response regardless of the circumstances surrounding the release or the mitigating factors, are emergency situations. The following designate an emergency situation:

- The situation is unclear to the person causing or discovering the spill;
- The release requires evacuation of persons (e.g. chemicals or contaminants could enter the air handling system of the building);
- The release involves or poses a threat of fire, suspected fire, explosion, or other imminent danger; conditions that are Immediately Dangerous to Life and Health (IDLH); high levels of exposure to toxic substances;
- The person(s) in the work area is uncertain that they can handle the severity of the hazard with the PPE and response equipment that has been provided and/or the exposure limit could easily be exceeded.

Specific procedures for responding to emergency situations including major hazardous material spill or release, fire, utility failure, weather, violence, and medical emergency, including chemical exposure, are detailed in the ***Emergency Resources Guide***.

Spill Response – Nuisance Spills

Conversely, small "nuisance" spills (less than 1 liter with low toxicity and low flammability) that do not pose significant safety or health hazards and do not have the potential to become emergencies within a short time frame are NOT emergency situations. The following situations are not emergencies:

- The person causing or discovering the release understands the properties and can make an informed decision as to the exposure level.
- The release can be appropriately cleaned by the lab personnel.
- 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 those assigned to clean up the activity.
- Incidental releases of hazardous substances that are routinely cleaned up by EHS need not be considered an emergency.

Nuisance spills may be cleaned up by properly trained and equipped laboratory staff using a chemical spill kit. Laboratories must have a minimum amount of personal protective equipment (PPE) and appropriate clean-up materials present prior to an incident. Before responding to a spill, the minimum PPE needed includes goggles, lab coat (sleeves rolled down), and nitrile or neoprene gloves.

1. The supplies needed to clean up a spill will depend on the quantity and type of chemical that is spilled. A recommended list of supplies is:

    a. polypropylene pads

b. heavy duty trash bags

c. Hazardous waste labels

d. A gallon plastic container with lid

e. Dust pan and brush

f. Laboratory tongs

g. Absorbent clay

2. Clean-up procedures are as follows:

   a. Secure the area of the spill.

   b. Don appropriate PPE and control further release and spread of spill material by righting containers and placing absorbent materials (e.g. absorbent pads) around the spill.

   c. Absorb any free liquid; spills of acids and bases can be easily absorbed into polypropylene pads, or a clay absorbent (cat litter). Once all of the free liquids are absorbed, place all of the absorbents and other contaminated spill clean-up residue and material into a heavy duty trash bag or plastic container that can be sealed.

   d. Neutralize any remaining residues using acids or bases for spilled corrosives, or warm soapy water for other chemicals, and decontaminate the area. **Never** use water for spilled chemicals that are water reactive!

   e. Inspect the area for spill residue, hidden contamination, or other unsafe conditions. Dispose of remaining contaminated materials. Label the container(s) as hazardous waste and submit a Hazardous Waste Removal Request to EHS.

<u>Power Outages</u>

In the event of building power failure and/or building evacuation, take the following steps:

1. Place lids on all open containers of volatile chemicals.
2. Lower the sash on chemical fume hoods
3. Shut down all equipment (leave cooling water and purge gases on as necessary)
4. Turn off ignition sources
5. Secure or isolate reactions that are underway (boiling liquid on a hot plate, distillations)
6. Take your books, coats, purse/wallet, keys, etc.
7. Close fire doors

Accident Reporting

Work-related injury must be reported to the PI/LS immediately after the incident occurs or the injury is treated. Employees must submit a completed *First Report of Injury* form to Human Resources within 24 hours of the incident.

Failure to follow the above procedure may result in delay of payment for medical expenses and/or jeopardize the proper leave status for your work injury.

Medical Consultation and Examinations

The University must provide employees who work with hazardous chemicals in the laboratory an opportunity to receive medical consultation, examination, and/or surveillance (as appropriate to the regulation) under the following circumstances:

- When an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee must be provided an opportunity to receive an appropriate examination.

- Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the Permissible Exposure Limit) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.

- Whenever an event takes place in the work area, such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultations shall be for the purpose of determining the need for a medical examination.

- All medical consultations and examinations must be performed by or under the direct supervision of a licensed physician and must be provided without cost to the employee, without loss of pay and at a reasonable time and place.

The following information should be provided at the time that an employee is referred for medical consultation and/or examination:

a. Identity of the chemical(s) to which the employee may have been exposed;

b. Description of the conditions under which the exposure occurred, including any quantitative exposure data, if available; and

c. A description of the signs and symptoms of exposure that the employee experienced, if any.

The employee’s department shall obtain a written opinion from the examining physician which shall include the following:

1. Any recommendation for further medical follow-up.

2. The results of the medical examination and any associated tests.

3. Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical found in the workplace.

4. A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

5. The written opinion of the physician shall not reveal specific finding of diagnoses unrelated to occupational exposure.

A medical surveillance program must be established for certain specified employees whose work assignments involve regular and frequent handling of toxicologically significant quantities of a chemical. An employee whose work involves regular and frequent handling of toxicologically significant quantities of a chemical should consult a qualified physician to determine on an individual basis whether a regular schedule of medical surveillance is desirable.

E. Laboratory Vacate Procedures

To protect University personnel or construction workers from chemical, biological, and/or radiological hazards associated with laboratory work, procedures for vacating a laboratory must be followed when a researcher or lab supervisor is:

- leaving the University and closing his/her laboratory
- retiring and closing his/her laboratory
- relocating his/her laboratory to a different building on campus
- leaving the University but transferring responsibility of his/her laboratory to another researcher
- temporarily vacating the laboratory for renovation

In order to ensure a speedy clearance procedure, please complete the EHS Laboratory Vacate Form and return it to EHS - Fax 410.651-7918. EHS is available to perform a laboratory survey to assist in identifying the tasks that must be finished for clearance of the space.

Instructions for Decontamination

Laboratory equipment contaminated with any chemical, biological, or radioactive material must Be properly decontaminated using the following procedures:

> Chemical Hazard: any surface which a hazardous chemical has come in contact with must be wiped down with a solution of warm soap and water. This applies only to areas that construction workers would be exposed to in the normal course of their work. For example, fume hoods (inside and out), laboratory bench tops, floors, refrigerators and sinks must be cleaned. Chemical containers must be moved and stored away from where renovation work is to be performed in the laboratory.
>
> Biological Hazard: Any surface which a biological hazard has come in contact with must be decontaminated. A solution of 1:10 household bleach (5.25% sodium hypochlorite) can be used to inactivate most infectious agents. The PI is responsible for verifying that this has been performed and that sodium hypochlorite was the appropriate material to use to inactivate the agent. This applies only to areas that construction workers would be exposed to in the normal course of their work. For example, laboratory bench tops, floors, biological safety cabinets and clean benches, centrifuges, and refrigerators/freezers must be decontaminated. Biological safety cabinets are required to be decontaminated prior to being moved or serviced. The cabinet then must be re-certified when it is installed in its new location. Please contact EHS to determine how the cabinet needs to be decontaminated well in advance of the planned move.
>
> Radiological Hazards: A "certification for unrestricted use" must be on file or obtained from the Radiation Safety Office. Contact Radiation Safety at 410.706.6281 for

additional information and instructions. All clean-up procedures must be performed using appropriate personal protective equipment (PPE).

Appendix I

Chemical Inventory

and

Material Safety Data Sheets

(To be supplied by Laboratory Supervisor)

Appendix II
Materials Subject to OSHA-Specific Standards

Use of any of the following materials may be subject to specific occupational safety and health standards as shown:

Asbestos, tremolite, anthophyllite and actinolite	29 CFR 1910.1001
4-Nitrobiphenyl	.1003
alpha-Naphthylamine	.1004
4,4'-Methylene bis(2-chloroaniline)	.1005
Methyl chloromethyl ether	.1006
3,3'-Dichlorobenzidine (and salts)	.1007
bis-Chloromethyl ether	.1008
beta-Naphthylamine	.1009
Benzidine	.1010
4-Aminodiphenyl	.1011
Ethyleneimine	.1012
beta-Propiolactone	.1013
2-Acetylaminofluorene	.1014
4-Dimethylaminoazobenzene	.1015
N-Nitrosodimethylamine	.1016
Vinyl Chloride	.1017
Arsenic (inorganic)	.1018
Lead	.1025
Cadmium	.1027
Benzene	.1028
Cotton dust	.1043
1,2-Dibromo-3-chloropropane	.1044
Acrylonitrile	.1045
Ethylene oxide	.1047
Formaldehyde	.1048
4,4'-Methylenedianiline	.1050
Methylene Chloride	.1052
Non-Asbestiform tremolite, anthophyllite and actinolite	.1101

Appendix III
Lists of Chemicals Categorized by Hazardous Characteristics

Table III. Specific Chemical Incompatibilities

A	B
Acetylene and monosubstituted acetylenes (RC≡CH)	Group IB and IIB metals and their salts Halogens Halogenating agents
Ammonia, anhydrous and aqueous	Halogens Halogenating agents Mercury Silver
Alkali and alkaline earth carbides hydrides hydroxides metals oxides peroxides	Water Acids Halogenated organic compounds Halogenating agents Oxidizing agents
Azides, inorganic	Acids Heavy metals and their salts Oxidizing agents
Cyanides, inorganic	Acids Strong bases
Mercury and its amalgams	Acetylene Ammonia, anhydrous and aqueous Nitric acid Sodium azide
Nitrates, inorganic	Acids Reducing agents
Nitric acid	Bases Chromic acid Chromates Metals Permanganates Reducing agents Sulfides Sulfuric acid
Nitrites, inorganic	Acids Oxidizing agents
Organic compounds	Oxidizing agents
Organic acyl halides	Bases Organic hydroxy and amino compounds
Organic anhydrides	Bases Organic hydroxy and amino compounds
Organic halogen compounds	Group IA and IIA metals Aluminum
Organic nitro compounds	Strong bases
Oxalic acid	Mercury and its salts Silver and its salts
Phosphorus	Oxidizing agents Oxygen Strong bases
Phosphorus pentoxide	Alcohols Strong bases Water
Sulfides, inorganic	Acids
Sulfuric acid (concentrated)	Bases Potassium permanganate Water

List A includes chemicals with a severe peroxide hazard by storage with exposure to air; chemicals should be discarded within 3 months. List B includes chemicals with a concentration hazard and should not be distilled or evaporated without first testing for the presence of peroxides; discard or test for peroxides after 6 months. List C includes chemicals with a rapid polymerization hazard initiated by internally formed peroxides; discard or test liquids for peroxides after 6 months.

Table IV. Common Peroxide-Forming Chemicals

List A* – Storage Hazard	List B* – Concentration Hazard	List C* – Polymerization Hazard[a]
Diisopropyl ether (isopropyl ether) Divinylacetylene (DVA) Potassium metal Potassium amide Sodium amide (sod amide) Vinylidene chloride (1-dichloroethylene)[a]	Acetyaldehyde diethyl acetyl (acetyl) Cumene (isopropylbenzene) Decalin (decahydronaphtalene) Dioxane Ethylene glycol dimethyl ether (glyme) Ethylene glycol ether acetates Ethylene glycol monoethers (cellosolves) Diacetylene (butadiene) Dicyclopentadiene Diethyl either (ether) Diethylene glycol dimethyl ether (diglyme) Furan Methylcyclopentane Methyl isobutyl ketone Tetrahydrofuran (THF) Tetralin (tetrahydronaphthalene) Vinyl ethers[a]	Normal Liquids[b]: Chloroprene (20chloro-1,3-butadiene) [c] Styrene Vinyl acetate Vinylpyridine Normal Gases[d]: Butadiene[c] Tetrafluoroethlene (TEE) [c] Vinylacetylene (MVA) Vinyl chloride

[a]Polymerizable monomers should be stored with a polymerization inhibitor from which the monomer can be separated by distillation just before use.

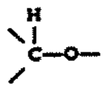
[b]Although common acrylic monomers such as acrylonitrile, acrylic acid, ethyl acrylate, and methyl methacrylate can form peroxides, they have not been reported to develop hazardous levels in normal use and storage

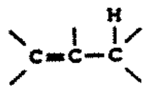
[c]The hazard from peroxides in these compounds is substantially greater when they are stored in the liquid phase, and if so stored without an inhibitor, they should be considered as in List A.

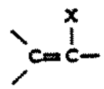
[d]Although air will not enter a gas cylinder in which gases are stored under pressure, these gases are sometimes transferred from the original cylinder to another in the laboratory, and it is difficult to determine the amount, if any, of residual air in the receiving cylinder. An inhibitor should be put into any such secondary cylinder before one of these gases is transferred into it; the supplier can suggest inhibitors to be used. The hazard posed by these gases is much greater if there is a liquid phase in such a secondary container, and even inhibited gases that have been put into a secondary container under conditions that create a liquid phase should be discarded within 12 months.

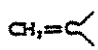
Table V. Structures of Chemicals That Are Prone to Form Peroxides

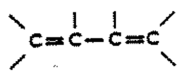
A. Organic Structures (in approximate order of decreasing hazard)

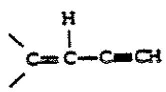
1.  Ethers and acetals with α hydrogen atoms

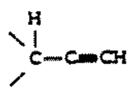
2.  Olefins with allylic hydrogen atoms

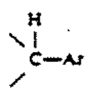
3.  Chloroolefins and fluoroolefins

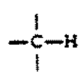
4.  Vinyl halides, esters, and ethers

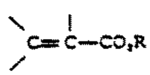
5.  Dienes

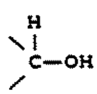
6.  Vinylacetylenes with α hydrogen atoms

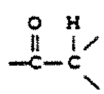
7.  Alkylacetylenes with α hydrogen atoms

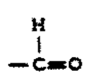
8.  Alkylarenes that contain tertiary hydrogen atoms

9.  Alkanes and cycloalkanes that contain tertiary hydrogen atoms

10.  Acrylates and methacrylates

11.  Secondary alcohols

12.  Ketones that contain α hydrogen atoms

13.  Aldehydes

14.  Ureas, amides, and lactams that have a hydrogen atom on a carbon atom attached to nitrogen.

B. *Inorganic Substances*

1. Alkali metals, especially potassium, rubidium, and cesium.
2. Metal amides.
3. Organometallic compounds with a metal atom bonded to carbon.
4. Metal alkoxides.

Although the tabulation of organic structures may seem to include a large fraction of the common organic chemicals, they are listed in the order of decreasing hazard. Reports of serious incidents involving the last five organic structural types are extremely rare, but they are included because laboratory workers should be aware that they can form peroxides that can influence the course of experiments in which they are used. The lists are not exhaustive, and analogous compounds that have any of the structural features given in Table V should be tested for the presence of peroxides before being used as solvents or being distilled. The recommended retention times begin with the date of synthesis or of opening the original container.

Pyrophoric Chemicals

- Grignard reagents, RMgX
- Metal alkyls and aryls, such as RLi, RNa, R^3Al, R^2Zn
- Metal carbonyls, such as Ni (CO), Fe (CO), $CO^2(CO)$
- Alkali metals such as Na, K
- Metal powders, such as Al, Co, Fe, Mg, Mn, Pd, Pt, Ti, Sn, Zn, Zr
- Metal hydrides, such as NaH, LiAlH
- Nonmetal hydrides, such as B^2h and other boraines, PH^3, AsH^3
- Nonmetal alkyls, such as R^3B, R^3P, R^3As
- Phosphorus (white)

Unstable Chemicals

- Acetylenic compounds, especially polyacetylenes, halo acetylenes, and heavy metal salts of acetylenes (copper, silver, and mercury salts are particularly sensitive)
- Acyl nitrates
- Alkyl nitrates, particularly polyol nitrates such as nitrocellulose and nitroglycerine
- Alkyl and acyl nitrites
- Alkyl perchlorates
- Ammine metal oxosalts: metal compounds with coordinated ammonia, hydrazine, or similar nitrogenous donors and ionic perchlorate, nitrate, permanganate, or other oxidizing group
- Azides, including metal, nonmetal, and organic azides
- Chlorite salts of metals, such as $AgCIO^2$ and $Hg(CIO^2)^2$
- Diazo compounds such as CH^2N^2
- Diazonium salts when dry
- Fulminates (silver fulminate, AgCNO, can form in the reaction mixture from the tollens' test for aldehydes if is allowed to stand for some time; this can be prevented by adding dilute nitric acid to the test mixture as soon as the test have been completed
- Hydrogen peroxide becomes increasingly treacherous as the concentration rises above 30%, forming explosive mixtures with organic materials and decomposing violently in the presence of transition metals
- N-Halogen compounds such as difluoroamino compounds and halogen azides
- N-Nitro compounds such as N-nitro methylamine, nitrourea, nitro guanidine, and nitric amide

- Oxo salts of nitrogenous bases: perchlorates, dichromate's, nitrates, iodates, chlorites, chlorates, and permanganates of ammonia, amines, hydroxylamine, guanidine, etc.
- Perchlorate salts. Most metal, nonmetal, and amine Perchlorates can be detonated and may undergo violent reaction in contact with combustible materials
- Peroxides and hydro peroxides, organic
- Peroxides (solid) that crystallize from or are left from evaporation of peroxidizable solvents
- Peroxides, transition-metal salts
- Picrates, especially salts of transition and heavy metals, such as Ni, Pb, HG Cu, and Zn; picric acid is explosive but is less sensitive to shock or friction than its metal salts and is relatively safe as a water-wet paste
- Polynitroalkyl compounds such as tetranitromethane and dinitroacetonitrile
- Polynitroaromatic compounds, especially polynitro hydrocarbons, phenols, and amines

The following is a list of a few combinations of common laboratory reagents that can produce explosions or that give reaction products that can explode without any apparent external initiating action. This list is by no means exhaustive; additional information of potentially explosive reagent combinations can be found in publications of the National Fire Protection Association.

- Acetone + chloroform in the presence of base
- Acetylene + copper, silver, mercury, or their salts
- Ammonia (including aqueous solutions) Cl^2, Br^2, or I^2
- Carbon disulfide + sodium azide
- Chlorine + an alcohol
- Chloroform or carbon tetrachloride + powdered Al or Mg
- Decolorizing carbon + an oxidizing agent
- Diethyl ether + chlorine (including a chlorine atmosphere)
- Dimethyl sulfoxide + an acyl halide. $SOCl^2$ or $POCl^3$
- Dimethyl sulfoxide + CrO^3
- Ethanol + calcium hypochlorite
- Ethanol + silver nitrate
- Nitric acid + acetic anhydride or acetic acid
- Picric acid + a heavy-metal, such as a Pb, Hg or Ag
- Silver oxide + ammonia + ethanol
- Sodium + a chlorinated hydrocarbon
- Sodium hypochlorite + an amine

Water-Reactive Chemicals

- Alkali metals
- Alkali metal hydrides
- Alkali metal amides
- Metal alkyls, such as lithium alkyls and aluminum alkyls
- Grignard reagents
- Halides of nonmetals, such as BCl^3, BF^3, PCl^3, PCl, SiCl, S^2Cl^2

- Inorganic acid halides, such as $POCl^3$, $SOCl^2$, SO^2Cl^2
- Anhydrous metal halides, such as $AlCl^3$, TiCl, ZrCl, SnCl
- Phosphorous pentoxide
- Calcium carbide
- Organic acid halides and anhydrides of low molecular weight

Appendix IV
Chemical Resistance Chart for Protective Gloves

Table VI. Resistance to Chemicals of Common Glove Material

Chemical	Natural Rubber	Neoprene	Nitrile	Vinyl
Acetaldehyde	G	G	E	G
Acetic Acid	E	E	E	E
Acetone	G	G	G	F
Acrylonitrile	P	G	--	F
Ammonium hydroxide (sat)	G	E	E	E
Aniline	F	G	E	G
Benzaldehyde	F	F	E	G
Benzene	P	F	G	F
Benzyl chloride	F	P	G	P
Bromine	G	G	--	G
Butane	P	E	--	P
Butyraldehyde	P	G	--	G
Calcium hypochlorite	P	G	G	G
Carbon disulfide	P	P	G	F
Carbon tetrachloride	P	F	G	F
Chlorine	G	G	--	G
Chloroacetone	F	E	--	P
Chloroform	P	F	G	P
Chromic acid	P	F	F	E
Cyclohexane	F	E	--	P
Dibenzyl ether	F	G	--	P
Dibutyl phthalate	F	G	--	P
Diethanolamine	F	E	--	E
Diethyl ether	F	G	E	P
Dibutyl phthalate	F	G	--	P
Diethanolamine	F	E	--	E
Diethyl either	F	G	E	P
Dimethyl sulfoxide[b]				
Ethyl acetate	F	G	G	F
Ethylene dichloride	P	F	G	P
Ethylene glycol	G	G	E	E
Ethylene trichloride	P	P	--	P
Fluorine	G	G	--	G
Formaldehyde	G	E	E	E
Formic acid	G	E	E	E

Glycerol	G	G	E	E
Hexane	P	E	--	P
Hydrobromic acid (40%)	G	E	--	E
Hydrochloric acid (conc)	G	G	G	E
Hydrofluoric acid (30%)	G	G	G	E
Hydrogen peroxide	G	G	G	E
Iodine	G	G	--	G
Methylamine	G	G	E	E
Methyl cellosolve	F	E	--	P
Methyl chloride	P	E	--	P
Methyl ethyl ketone	F	G	G	P
Methylene chloride	F	F	G	F
Monoethanolamine	F	E	--	E
Morpholine	F	E	--	E
Naphthalene[a]	G	G	E	G
Nitric acid (conc)	P	P	P	G
Perchloric acid	F	G	F	E
Phenol	G	E	--	E
Phospheric acid	G	E	--	E
Potassium hydroxide (sat)	G	G	G	E
Propylene dichloride	P	F	--	P
Sodium hydroxide	G	G	G	E
Sodium hypochlorite	G	P	F	G
Sulfuric acid (conc)	G	G	F	G
Toluene	P	F	G	F
Trichloroethylene	P	F	G	F
Tricresyl phosphate	P	F	--	F
Triethanolamine	F	E	E	E
Trinitrotolulene	P	E	--	p

(E = Excellent, G = Good, F = Fair, P = Poor)

[a]Aromatic and halogenated hydrocarbons will attack all types of natural and synthetic glove materials. Should swelling occur, the user should change to fresh gloves and allow the swollen gloves to dry and return to normal.

[b]No data on the resistance to dimethyl sulfoxide or natural rubber, neoprene, nitrile rubber, or vinyl materials are available; the manufacturer or the substance recommends the use of butyl rubber gloves.