11-22-2019

Chemical Hygiene Plan Template and Guide

University of Maine System

Department of
[Enter Departments Name Here]
Chemical Hygiene Plan
[Current Year]

This program has been reviewed and approved by:

Date	Name	Department Safety Officer (Or other Title)
Date	Name	Department Chair (Or other Title)

TABLE OF CONTENTS

Chemical Hygiene Plan Template and Guide

Introduction and Purpose

The primary goal of this Chemical Hygiene Plan is to protect human life and property of The University of Maine System (UMS). This template serves to assist departments across the University of Maine System for writing their own Chemical Hygiene Plans (CHP). It provides guidelines for managing laboratory operations and chemical use in a safe, effective, and compliant manner. The regulatory requirements for maintaining a CHP are found in the Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.1450 (Aka…The Lab Standard) and its associated appendices. Compliance with all other applicable OSHA standards, including but not limited to those concerning electrical safety, walking/working surfaces, machine guarding or means of egress, must still be addressed within the laboratory. While writing individual plans, departments must also give consideration to the requirements of OSHA's General Duty Clause (Section 5 (a) (1)) which serves to enhance the safety of all laboratory operations by requiring departments to include additional safety considerations and requirements as outlined in their Standard Operating Procedures or Guidelines (SOP's, SOG's).

The Lab Standard is written to allow the flexibility needed in a research setting where hazardous chemicals are used in small quantities. Each department under the Lab Standard is required to develop a written CHP that addresses the unique hazards for their particular work areas. Each individual working in the area must be trained on the area-specific CHP. By agreement with the Maine Department of Labor, shops using small quantities of chemicals are allowed to use the Lab Standard as an alternative to the Hazard Communication Standard (at their discretion). All other work areas where hazardous chemicals are used must follow with the University/Campus Hazard Communication (HAZCOM) Program.

In order to use this approach the work area must meet all of the following conditions:

- Chemical manipulations are carried out on a laboratory scale (defined as relatively small quantities of hazardous chemicals are used on a non-production basis);
- Multiple chemical procedures or chemicals are used; and
- Protective laboratory practices and equipment are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

The written Chemical Hygiene Plan (CHP) must:

- Protect employees from health hazards associated with chemicals in the laboratory;
- Maintain exposures to hazardous chemicals below published Permissible Exposure Limits (PELs) and the limits specified in 29 CFR 1910.1450(c);
- Be readily available to employees working in the area and available upon request to employee representatives and outside regulatory agencies (I.e. Department of Labor)
- It must incorporate 8 elements:
    - Responsibilities
    - Employee Information and Training

- Requirements for prior approval of laboratory activities
- A requirement that fume hoods and other protective equipment are functioning properly and specific measures that will be taken to ensure proper and adequate performance of such equipment
- Measures to reduce employee exposure to hazardous chemicals
- Standard Operating Procedures (SOP) and/or Guidelines for safety and health.
- Special precautions for work with Particularly Hazardous Substances (PHS)
- Medical consultation and medical examinations

The **[Insert your department name here]** department will review and evaluate the effectiveness of their departmental/laboratory CHP at least annually and update it as necessary. Copies of this plan are available in **[Insert Location(s) where this plan can be found in your department].** A copy of this template may be found on the University of Maine System, Safety Management (SM) web page under "SM Documents," then "Forms." If you have any questions related this template, please contact SM via email at sem@maine.edu or phone 581-4055.

1. Program Administration and Chemical Hygiene Responsibilities

Individuals and organizations at the University of Maine have specific responsibilities under the Chemical Hygiene Plan Program. In particular, these responsibilities include, but are not limited to:

1.1. University of Maine System Safety Management (SM)

- Advises the campus community on the current regulatory requirements concerning worker health and safety and protection of the environment
- Provides Safety Training for a variety of subject areas
- Conducts annual fume hood inspections. (Certifications are contracted out)
- Conducts periodic inspections of laboratories to evaluate for worker health and safety and compliance with institutional, local, state and federal requirements
- Assists with laboratory design issues upon request
- Serves as a resource for chemical and worker health and safety issues and concerns and assists with incident investigations
- Reviews donated equipment or chemicals for compliance with local, state and federal regulations prior to acceptance and at the request of the recipient
- Assists individual departments or laboratory managers with CHP, SOP/SOG development, Hazard and Personal Protective Equipment (PPE) assessments for laboratory processes upon request
- Manages biological and hazardous waste disposal
- Assists departments with preparing shipments of hazardous chemicals and maintaining Department of Transportation (DOT) and International Air Transportation Association (IATA) compliance

1.2. Office of Human Resources (HR):

- Maintains all medical records according to state and federal confidentiality requirements. Records for medical evaluations will be kept for a period of 30 years following the last date of employment for each individual. Records for exposure evaluations will be kept for a period of 30 years.
- Schedules medical evaluations and surveillance, as required and applicable OSHA standards, or as recommended by medical personnel, laboratory managers or SM
- Screens job descriptions for baseline medical surveys

1.3. Department of Risk Management

- Manages all Workers' Compensation claims and the University of Maine Workers' Compensation program
- Manages the University of Maine's loss exposures by identifying the types of accidental losses faced by the University, analyzing the different types and sizes of these loss exposures and deciding how to handle and finance these losses
- Receives and processes reports of incidents, injury, and property damage

1.4. Facilities Management (FM)

- Maintains mechanical ventilation systems (including fume hoods, local exhaust ventilation systems, and makeup air and general ventilation) according to existing local, state and federal standards
- Performs regular preventive maintenance on laboratory fume hood fans and motors
- Maintains laboratory and building facility systems (including air compressors, chillers, HVAC systems, electrical, plumbing, etc.)
- Maintains, conducts and documents annual inspections of emergency eyewashes and showers. ***Note: Plumbed eyewash stations within each work area should be inspected and logged weekly by the occupants to ensure appropriate function and temperature.***
- Performs standard housekeeping/janitorial services in common areas of buildings such as hallways, conference rooms and offices
- Performs fire extinguisher inspections and maintenance according to local, state and federal regulations
- Conducts life safety (emergency light, sprinkler and fire alarm) inspections and maintenance according to local, state and federal regulations
- Notifies occupants of non-routine maintenance, repair and cleaning activities in laboratories prior to the commencement of work.
- Conducts required ladder inspections for FM-owned ladders and step stools, located in laboratory areas
- Maintains adequate lighting levels necessary for laboratory work
- Responsible for repairing identified safety concerns or hazards related to building or mechanical systems
- Notify appropriate personnel when recognized or suspected safety hazards are encountered.
- Responsible for facilitating or evaluating the impacts of renovation activities on potential health and safety concerns, in consultation with SM, prior to the start of work activities

1.5. Departmental Chair or Director
[Current Chair Directors Name]

- Responsible for the writing, implementing and updating their CHP
- Provides a copy of the departmental CHP to SM upon initial implementation and when significant changes are made.
- Maintains laboratory and departmental compliance with the written CHP.
- Delegates to the Departmental Chemical Hygiene Officer/Committee the requisite authority necessary to conduct related activities.

1.6. Departmental Chemical Hygiene and/or Safety Officer
[CHO/Safety Officer Name]

- Works with administrators and other departmental employees to develop generic and/or specific CHPs
- Assists Departmental Chairs and Directors with addressing regulatory compliance within the departmental laboratories
- Conducts random inspections to monitor compliance with their CHP
- Conducts departmental training sessions, as appropriate

- Disseminates information to laboratory managers/supervisors, principal investigators, teaching assistants and classroom instructors, as appropriate
- Monitors the procurement, use and disposal of chemicals in the laboratories
- Works with Safety Management to address worker health and safety concerns, engineered controls and improved processes that will minimize chemical usage and chemical and biological waste
- Serves as a point of contact when feasible by providing information to SM and emergency responders that will assist them in the mitigation and cleanup of spills or in the investigation of potential releases and odors

1.7. Laboratory Manager/Supervisors, Principal Investigators, Teaching Assistants and Classroom Instructors

- Submits a Pre-employment checklist to the Human Resources Department
- Ensures that workers know the chemical hygiene rules, protective equipment is available, in working order, and that appropriate training is provided
- Provides regular, formal chemical hygiene and housekeeping inspections, including spill kits and weekly flushing of eyewash stations located inside their work area/laboratory space
    - Note: This does not include eyewash stations in the hallways. Showers are ONLY inspected by FM.
- Submits work orders to FM for the repair of building equipment such as fume hood or repairs related to building or mechanical systems
- Performs Hazard Assessments and determines the required levels of PPE
- Develops SOPs or SOGs in coordination with individual group members for laboratory specific procedures that support prudent practices
- Identifies and controls sources of hazardous conditions within the laboratory
- Maintains ultimate responsibility for compliance, chemical hygiene and safety within the laboratory
- Reports incidents involving employee overexposures, injuries, and property damage to Risk Management
- Schedules medical evaluations and surveillance as required by the CHP and applicable OSHA standards or as recommended by medical personnel, laboratory managers or the University CHO
- Serves as a point of contact when feasible by providing information to emergency responders that will assist them in the mitigation and cleanup of spills or in the investigation of potential releases and odors

1.8. Laboratory or Technical Worker

- Attends required training programs
- Develops and practices good chemical hygiene habits
- Reports suspected or potential safety and health hazards to the laboratory manager
- Wears prescribed PPE
- Reviews appropriate laboratory and/or departmental SOPs or SOGs and demonstrates proficiency in the performance of assigned tasks (including appropriate laboratory hygiene and safety practices)
- Maintains the ultimate responsibility for his/her personal safety on the job

2. Employee Information and Training

All employees of the University of Maine System are required to participate in safety training. Employees include: Faculty, staff, graduate students, post docs, and student employees (including work-study students, teaching assistants, resident directors, and any other person who receives pay or compensation for work performed). Students and volunteers are provided with safety information as necessary to safely perform assigned tasks.

2.1. General Safety Training

- Basic Safety Training (All employees, required annually).
- Department Annual Safety Training (All employees, required annually).
    - This training is provided by the area supervisor to all employees, and includes Fire Prevention Plans and Emergency Action Plans. CHP Training may be included.
- Specialized Safety Training (Depending on Job Tasks)
    - Examples of Specialized Safety Training include Computer Workstations, Confined Space Entry, Bloodborne Pathogens, Lockout/Tagout, Hazardous Waste, Radiation Safety, Laser Safety, Respirators, Chemical Spill Training, Incident Reporting and Investigations, Ergonomics, Supervisor Safety Training, etc.

A comprehensive list of required Safety Training is located on the University of Maine System, Safety Management (SM) web page under "SM Training." (2 of 8 pages shown below)

Department: The University of Maine System / Safety Management
Document: Safety Training Requirements Listing
Page 1 of 8
0809005, 06/18/18

Safety Training Requirements Listing

General Information

All University of Maine System (UMS) employees must complete required safety training. Employees include Faculty, Staff, Graduate Students, Post Docs, and Student Employees (including work study students, Teaching Assistants, Resident Directors, and any other person who receives pay or compensation for work performed). This also includes temporary and part-time employees.

Training Records and Documentation

All training must be documented and maintained in the work area either by the supervisor or in the employee's records.

How to Receive Training

Training courses are either on-line or conducted by the campus safety staff, the UMS Safety Management (SM) department, the employee's supervisor, or an outside training source/venue.

Please see your supervisor to review your specific training requirements.

Contact Information

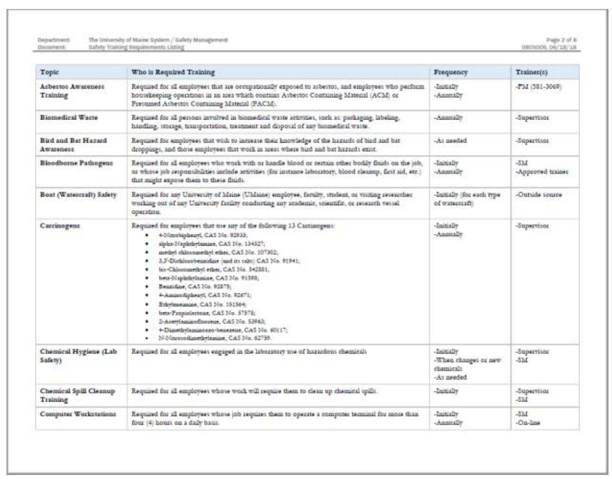
If you have any questions about the training requirements, or how to obtain the training, please contact your campus safety personnel or the UMS Safety Management department at 581-4055 or email us at sem@maine.edu.

University of Maine System / Safety Management
5784 York Complex Building #7
Orono, Maine 04469
Phone: 207.581.4055 | Fax: 207.581.4085 | E-mail: sem@maine.edu
A Member of the University of Maine System

Complete Listing of Safety Training Requirements and Information

Any training requirements listed below where the Trainer is listed as 'On-line', you may visit the UMS Safety Management webpage on the UMS MyCampus portal.

Topic	Who is Required Training	Frequency	Trainer(s)
Advanced Emergency Action Plan (Evacuation Coordinator) Training	All employees who remain behind as "Evacuation Coordinators" that assist persons in orderly evacuation of buildings in an emergency.	-Initially	-SM
Annual Basic Safety Training	All employees	-Initially -Annually	-SM -On-line



Department: The University of Maine System / Safety Management
Document: Safety Training Requirements Listing
Page 2 of 8
0809005, 06/18/18

Topic	Who is Required Training	Frequency	Trainer(s)
Asbestos Awareness Training	Required for all employees that are occupationally exposed to asbestos, and employees who perform housekeeping operations in an area which contains Asbestos Containing Material (ACM) or Presumed Asbestos Containing Material (PACM).	-Initially -Annually	-FM (581-3069)
Biomedical Waste	Required for all persons involved in biomedical waste activities, such as: packaging, labeling, handling, storage, transportation, treatment and disposal of any biomedical waste.	-Annually	-Supervisor
Bird and Bat Hazard Awareness	Required for employees that wish to increase their knowledge of the hazards of bird and bat droppings, and those employees that work in areas where bird and bat hazards exist.	-As needed	-Supervisor
Bloodborne Pathogens	Required for all employees who work with or handle blood or certain other bodily fluids on the job, or whose job responsibilities include activities (for instance laboratory, blood cleanup, first aid, etc.) that might expose them to these fluids.	-Initially -Annually	-SM -Approved trainer
Boat (Watercraft) Safety	Required for any University of Maine (UMaine) employee, faculty, student, or visiting researcher working out of any University facility conducting any academic, scientific, or research vessel operation.	-Initially (for each type of watercraft)	-Outside source
Carcinogens	Required for employees that use any of the following 13 Carcinogens: • 4-Nitrobiphenyl, CAS No. 92933; • alpha-Naphthylamine, CAS No. 134327; • methyl chloromethyl ether, CAS No. 107302; • 3,3'-Dichlorobenzidine (and its salts) CAS No. 91941; • bis-Chloromethyl ether, CAS No. 542881; • beta-Naphthylamine, CAS No. 91598; • Benzidine, CAS No. 92875; • 4-Aminodiphenyl, CAS No. 92671; • Ethyleneimine, CAS No. 151564; • beta-Propiolactone, CAS No. 57578; • 2-Acetylaminofluorene, CAS No. 53963; • 4-Dimethylaminoazo-benzene, CAS No. 60117; • N-Nitrosodimethylamine, CAS No. 62759.	-Initially -Annually	-Supervisor
Chemical Hygiene (Lab Safety)	Required for all employees engaged in the laboratory use of hazardous chemicals	-Initially -When changes or new chemicals -As needed	-Supervisor -SM
Chemical Spill Cleanup Training	Required for all employees whose work will require them to clean up chemical spills.	-Initially	-Supervisor -SM
Computer Workstations	Required for all employees whose job requires them to operate a computer terminal for more than four (4) hours on a daily basis.	-Initially -Annually	-SM -On-line

2.2. Chemical Hygiene Plan Training

The **[Insert Department Name Here]** will provide employees with information and training for their CHP and training specific to the tasks they perform, the environment they are working in and the hazards presented by that work. Training will be provided at the time of an individual's initial assignment, when there is a change in job description, job location, or CHP, or if an employee demonstrates that training was not understood (i.e., fails to follow safety precautions). Training includes:

- The location, availability and details of the Departmental and/or Laboratory CHP
- The physical and health hazards of chemicals in the work area
- The measures individuals can take to protect themselves from these hazards, including specific procedures the University or the laboratory has implemented to protect individuals from exposure to hazardous chemicals (i.e.; appropriate work practices, emergency procedures, and personal protective equipment)
- Methods and observations that may be used to detect the presence or release of a hazardous chemical such as monitoring conducted by the University, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, and signs and symptoms associated with exposure.
- The location and availability of known reference materials including, but not limited to, Safety Data Sheets (SDSs) received from the chemical supplier
    - SDSs will be accessible, in or near the individual laboratories, during normal working hours. SDSs for chemicals/products that are no longer in use should be archived with the department and maintained for a period of 30 years.
- The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard
- The location and proper use of available protective apparel and equipment (PPE).

A CHP Training Checklist is available to assist trainers and can be found on the University of Maine System, Safety Management (SM) web page under "SM Training."

The **[Insert Department Name Here]** requires the following departmental specific training to be completed by employees based on their job descriptions and the tasks they perform:

[List departmental specific/specialized safety training here]

2.3. Recordkeeping:

The ***[Insert Department Name Here]*** will document and maintain all training in their work areas (either by the supervisor or in the employee's records). Personnel training records will be kept in **[Describe where records can be found].** The supervisor or designee must retain a record of training for each employee as confirmation of safety training conducted. Training records will include

- The name and signature of the attendee; the name of the training course, the name of the instructor and the date the course was administered.
- Records will be maintained for a period of 3 years unless otherwise specified.

The ***[Insert Department Name Here]*** will review and keep a copy (written or electronic) of the University Maine System Personal Protective Equipment Policy (or an equivalent campus policy) and maintain PPE Hazard Assessments for the duration of the assessed activity plus three years. Amendments to original PPE Hazard Assessments will be maintained with the original. PPE hazard assessments will be kept with **[Describe where the assessments can be found]**

Record Examples

Safety Training Roster

Training Course:		Instructor's Name:	Email:
Campus:		Instructor's Signature:	Date of Training:
Employee Name: (Last, First)	Employee ID#	Department	Employee Signature

Training Record for Laboratory Emergency Procedures

This document is to record that training has been received for Laboratory Emergency Procedures including:

- Location and use/activation of the following Emergency Equipment
- Emergency Eyewash
- Emergency Shower
- Evacuation Alarm System
- Spill Kit
- Telephone
- Emergency Chemical Spill Procedures Guide
- Chemical Spill Guidelines

Employee Name:	Employee ID:	Date of Training
Department / Building:	Position:	
Trainer Signature:	Employee Signature:	

3. Basic Safety Guidelines for Laboratory Work

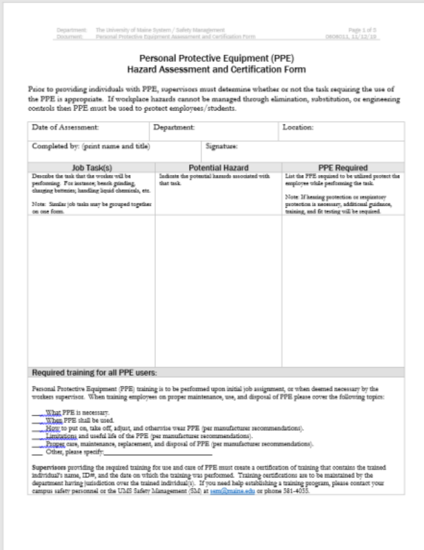
The following guidelines are provided to ensure safety and health while working in the laboratory. These are minimum guidelines only and area specific SOP's/SOG's must be in place or developed for hazards not adequately addressed within these guidelines. This information must be communicated to all laboratory employees. Employees are expected to conduct themselves to the best standards of laboratory technique and precaution.

Prior to performing any laboratory work, supervisors and employees must:

- Review SDSs and become familiar with hazard information and exposure potential for the chemicals they will be using
- Research/review the appropriate methods and equipment for minimizing hazard and exposure risks (Engineering and Administrative Controls). Assessment information must be in the SOP/SOG.
- Evaluate PPE that will be required and include these assessments in the written SOP/SOG.
- Plan positioning of equipment/experiment before beginning any new operation.

A copy of the University of Maine System Personal Protective Equipment Policy (if you are not using a separate campus policy) may be obtained on the Safety Management (SM) web page under "SM Documents," then "Policies."

A "Personal Protective Equipment (PPE) Hazard Assessment and Certification Form" may be found on the University of Maine System, Safety Management (SM) web page under "SM Documents," then "Forms."



Personal Protective Equipment (PPE)
Hazard Assessment and Certification Form

Prior to providing individuals with PPE, supervisors must determine whether or not the task requiring the use of the PPE is appropriate. If workplace hazards cannot be managed through elimination, substitution, or engineering controls then PPE must be used to protect employees/students.

Date of Assessment:	Department:	Location:
Completed by: (print name and title)	Signature:	

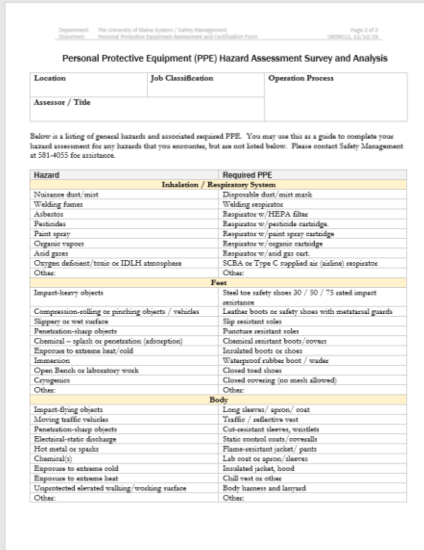
Job Task(s)	Potential Hazard	PPE Required
Describe the task that the worker will be performing. For instance; bench grinding, charging batteries; handling liquid chemicals, etc. Note: Similar job tasks may be grouped together on one form.	Indicate the potential hazards associated with that task.	List the PPE required to be utilized protect the employee while performing the task. Note: If hearing protection or respiratory protection is necessary, additional guidance, training, and fit testing will be required.

Required training for all PPE users:

Personal Protective Equipment (PPE) training is to be performed upon initial job assignment, or when deemed necessary by the workers supervisor. When training employees on proper maintenance, use, and disposal of PPE please cover the following topics:

___ What PPE is necessary.
___ When PPE shall be used.
___ How to put on, take off, adjust, and otherwise wear PPE (per manufacturer recommendations).
___ Limitations and useful life of the PPE (per manufacturer recommendations).
___ Proper care, maintenance, replacement, and disposal of PPE (per manufacturer recommendations).
___ Other, please specify:________________

Supervisors providing the required training for use and care of PPE must create a certification of training that contains the trained individual's name, ID#, and the date on which the training was performed. Training certifications are to be maintained by the department having jurisdiction over the trained individual(s). If you need help establishing a training program, please contact your campus safety personnel or the UMS Safety Management (SM) at sem@maine.edu or phone 581-4055.

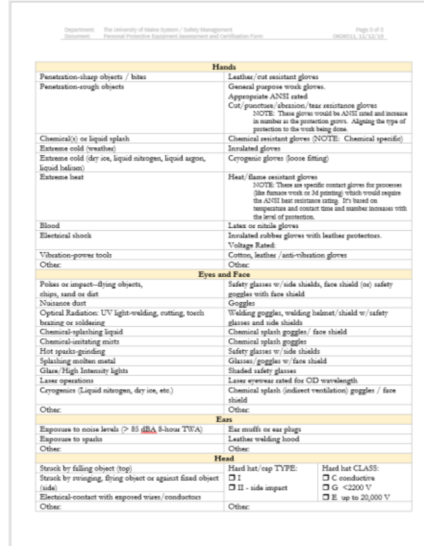


Personal Protective Equipment (PPE) Hazard Assessment Survey and Analysis

Location	**Job Classification**	**Operation Process**
Assessor / Title		

Below is a listing of general hazards and associated required PPE. You may use this as a guide to complete your hazard assessment for any hazards that you encounter, but are not listed below. Please contact Safety Management at 581-4055 for assistance.

Hazard	Required PPE
Inhalation / Respiratory System	
Nuisance dust/mist	Disposable dust/mist mask
Welding fumes	Welding respirator
Asbestos	Respirator w/HEPA filter
Pesticides	Respirator w/pesticide cartridge.
Paint spray	Respirator w/paint spray cartridge
Organic vapors	Respirator w/organic cartridge
Acid gases	Respirator w/acid gas cart.
Oxygen deficient/toxic or IDLH atmosphere	SCBA or Type C supplied air (airline) respirator
Other:	Other:
Feet	
Impact-heavy objects	Steel toe safety shoes 30 / 50 / 75 rated impact resistance
Compression-rolling or pinching objects / vehicles	Leather boots or safety shoes with metatarsal guards
Slippery or wet surface	Slip resistant soles
Penetration-sharp objects	Puncture resistant soles
Chemical – splash or penetration (adsorption)	Chemical resistant boots/covers
Exposure to extreme heat/cold	Insulated boots or shoes
Immersion	Waterproof rubber boot / wader
Open Bench or laboratory work	Closed toed shoes
Cryogenics	Closed covering (no mesh allowed)
Other:	Other:
Body	
Impact-flying objects	Long sleeves/ apron/ coat
Moving traffic vehicles	Traffic / reflective vest
Penetration-sharp objects	Cut-resistant sleeves, wristlets
Electrical-static discharge	Static control coats/coveralls
Hot metal or sparks	Flame-resistant jacket/ pants
Chemical(s)	Lab coat or apron/sleeves
Exposure to extreme cold	Insulated jacket, hood
Exposure to extreme heat	Chill vest or other
Unprotected elevated walking/working surface	Body harness and lanyard
Other:	Other:



Hands		
Penetration-sharp objects / bites	Leather/cut resistant gloves	
Penetration-rough objects	General purpose work gloves. Appropriate ANSI rated Cut/puncture/abrasion/tear resistance gloves NOTE: These gloves would be ANSI rated and increase in number as the protection grows. Aligning the type of protection to the work being done.	
Chemical(s) or liquid splash	Chemical resistant gloves (NOTE: Chemical specific)	
Extreme cold (weather)	Insulated gloves	
Extreme cold (dry ice, liquid nitrogen, liquid argon, liquid helium)	Cryogenic gloves (loose fitting)	
Extreme heat	Heat/flame resistant gloves NOTE: There are specific contact gloves for processes (like furnace work or 3d printing) which would require the ANSI heat resistance rating. It's based on temperature and contact time and number increases with the level of protection.	
Blood	Latex or nitrile gloves	
Electrical shock	Insulated rubber gloves with leather protectors. Voltage Rated:	
Vibration-power tools	Cotton, leather /anti-vibration gloves	
Other:	Other:	
Eyes and Face		
Pokes or impact--flying objects, chips, sand or dirt	Safety glasses w/side shields, face shield (or) safety goggles with face shield	
Nuisance dust	Goggles	
Optical Radiation: UV light-welding, cutting, torch brazing or soldering	Welding goggles, welding helmet/shield w/safety glasses and side shields	
Chemical-splashing liquid	Chemical splash goggles/ face shield	
Chemical-irritating mists	Chemical splash goggles	
Hot sparks-grinding	Safety glasses w/side shields	
Splashing molten metal	Glasses/goggles w/face shield	
Glare/High Intensity lights	Shaded safety glasses	
Laser operations	Laser eyewear rated for OD wavelength	
Cryogenics (Liquid nitrogen, dry ice, etc.)	Chemical splash (indirect ventilation) goggles / face shield	
Other:	Other:	
Ears		
Exposure to noise levels (> 85 dBA 8-hour TWA)	Ear muffs or ear plugs	
Exposure to sparks	Leather welding hood	
Other:	Other:	
Head		
Struck by falling object (top)	Hard hat/cap TYPE: ❒ I ❒ II - side impact	Hard hat CLASS: ❒ C conductive ❒ G <2200 V ❒ E up to 20,000 V
Struck by swinging, flying object or against fixed object (side)		
Electrical-contact with exposed wires/conductors		
Other:	Other:	

3.1. General Safety

- Know the location of safety equipment: Fire alarms, extinguishers, and emergency shower and eyewash stations.
- Ensure that a spill kit is available and that employees know how to properly use it.
- Know the proper emergency response procedures (fire, spills, medical, etc.) and emergency contact information.
- Avoid distracting activities while handling hazardous chemicals including practical jokes or other behavior that might confuse, startle, or distract another worker
- Use equipment and hazardous chemicals only for their intended purpose
- Recognize unsafe conditions in the laboratory and notify the supervisor so that corrective action can be initiated
- Inspect equipment before each use. Look for signs of leaks, tears, and other damage.
- Avoid tasting, smelling, direct contact or unnecessary handling of hazardous chemicals
- Use a fume hood for operations that might result in the release of hazardous chemical vapors or dust.
- The use of highly hazardous chemicals should be approved by the appropriate laboratory manager and have a SOP/SOG developed prior to commencing work. Notification of intent to use highly hazardous chemicals should be made to SM in writing before chemicals are purchased and/or used in experimental protocols.
- Pets and children are not allowed in laboratories or hazardous work areas

3.2. Health and Hygiene

- Know the types of protective equipment required (eye, face, hands, body), have ample supply available, and wear them when required
- Personal Clothing
  - Confine long hair and loose clothing
  - Wear footwear that fully covers the feet to protect against spills
  - Trousers or skirts of knee length or beyond are recommended; wear a lab coat or apron of below knee length when wearing short garments

  - Avoid loose jewelry and loose, flowing garments
- Do not leave the laboratory while wearing protective gloves.
- Wash non-disposable gloves before removing them, and never take these gloves out of the laboratory.
- Wash exposed skin areas thoroughly after handling chemicals and before leaving the work area.
- Do not mouth pipette or use mouth suction to siphon.
- Do not store or consume food or beverages of any kind where chemicals are manipulated or stored. This includes chewing gum.
- Tobacco use is prohibited on campus.
- Do not apply cosmetics where chemicals are manipulated or stored.
- Do not store food or drinks in a refrigerator, freezer, or cooling unit that is used to store chemicals.
- No employee or student will be allowed to consume or store food or beverages in any area exposed to hazardous chemicals.
- No food or beverage should ever be placed in a microwave oven, heating device, or any other receptacle that is used to conduct experimental processes using hazardous chemicals.

3.3. **Housekeeping**

- Maintain the laboratory in good order, clean, and well-organized.
- Keep aisles, doorways, and exits clear of furniture, boxes, equipment, and other impediments that could hinder the swift exit from the work area in case of an emergency.
- Store chemicals according to compatibility and with proper labeling. Do not store hazardous chemicals above shoulder height.
- Do not use hallways, stairways, or egress paths as storage areas.
- Storage must not block access to emergency eyewashes, fire extinguishers, or drench showers
- Materials must not be stored in front of electrical panels or service panels. A minimum of 36 inches of space shall be maintained in front of existing panels.
- Store heavy items below waist height.
- Do not allow cords, tubing, and other similar materials to become trip hazards or hindrances to safe working and emergency egress.
- Designate a separate, appropriately labeled or marked, protected receptacle for the collection of non-contaminated broken glassware.
- Do not allow dirty equipment and glassware to accumulate on lab benches, counter tops, or in fume hoods.
- Clean up all non-emergency spills immediately
- Dispose of spill materials and waste in accordance with the disposal guidelines provided in this CHP
- Clean up the work area upon completion of an operation or at the end of each day.

3.4. **Chemical Procurement**

- Obtain SDSs for all chemicals received, stored and handled in the laboratory or work area. In general, SDS's may be obtained electronically (E.g PDF format) from the suppliers website. Paper copies of SDS should be made unless you can demonstrate that laboratory users have easy, readily available access to the electronic copies.

- Always purchase the minimum amount possible for an operation or procedure.
    - Evaluate existing chemical stocks.
    - Use or substitute less hazardous chemicals.
- Labels on incoming chemicals must be intact and clearly legible.
- Chemical containers must be constructed from material that is compatible with the chemical
- Chemical containers must have tight fitting lids that prevent a spill when the container is tipped.
- All containers must be labeled with contents and hazards (including gas cylinders).
- It is recommended that upon receipt of a new chemical it should be labeled with the date received, the name of the person who obtained it, and color coded.
- Direct all deliveries of chemical containers to a central storeroom or chemical receiving area.

3.5. **Chemical Storage**

- Chemicals shall be segregated and stored by compatibility according to a standardized and easily understood system. Refer to the "BAKER color coding system" below as an example.
- Sufficient space should be provided so that incompatible chemicals can be segregated.
- Polypropylene or polyethylene plastic containers should be used to provide both segregation and secondary containment.
- Secondary containment should be provided for liquids. Secondary containment is defined as a chemically resistant container that will hold 110% of the volume stored within that container.
- Flammable materials must be stored in a flammable safety cabinet (or metal cabinet if a flame cabinet is not available) when cabinet space is available. Small quantities (500 ml) of ethanol or isopropanol kept in wash squirt/spray bottles may be kept on the work bench when laboratory work is being performed or classes are in session. Use of other chemicals where fire and toxicity hazards are higher (such as acetone and methanol) in a similar manner, should be restricted to laboratory work during the day. These should be stored in a flame cabinet at the end of the day.
- Cabinets are required for acids, bases and oxidizers.
- Limit storage of chemicals on bench tops and other work areas.
- Fume hoods used for chemical storage must have a sign designating "Chemical Storage Only" and these hoods cannot be used for chemical manipulations or procedures.
- Avoid establishing storage areas in locations that subject chemical containers to heat or direct sunlight.
- Avoid establishing chemical storage areas near exits or paths of egress.
- Toxic, highly toxic, and volatile chemicals that have been opened require special attention:
    - Segregate the above chemicals in a well identified, labeled area that is equipped with local exhaust ventilation; and
    - Containers with the potential for spillage must be stored within appropriate chemical resistant secondary storage capable of containing the contents of the container.
    - Restricted access is recommended for highly toxic chemicals to prevent unauthorized use.

- Shelves must be capable of supporting the chemical containers, resistant to the chemicals, and should have a lip.
- Nothing should be stored over shoulder height of an employee without special provisions, such as a proper step stool.
- Chemical storage areas need general ventilation. Specific chemicals may require special ventilation.
- If refrigeration is required, then an approved refrigerator (special models for flammable or explosive storage) with proper signage needs to be provided.
- Bench tops should not be used as chemical storage areas.
- Chemicals should not be stored on the floor (exception: properly secured gas cylinders).
- Gas cylinders must be segregated according to compatibility, stored away from heat sources, upright, and secured so that they will not fall over. Gas cylinders must have cap installed when not in use. Contact Safety Management if you need help setting up a lab space.
- Hazardous chemicals must be separated from eating and drinking areas in order to prevent possible ingestion of toxic materials. Refrigerators, freezers, and microwaves used for the storage or processing of hazardous chemicals must be labeled with wording that positively identifies that the equipment's use is restricted. Words such as "CHEMICAL STORAGE ONLY", or "CHEMICAL PROCESSING ONLY", are appropriate. For clarity, foods that are used in experiments should be labeled "Not for Human Consumption" or other appropriate wording.

Baker Storage Color Coding System (NFPA 704)	
Color	**Storage Notes**
WHITE	Corrosive. May be harmful to eyes, mucous membranes and skin. Store separate from combustible and flammable chemicals.
YELLOW	Reactive/Oxidizer. May react violently with water, air or other chemicals. Store separate from combustible and flammable reagents.
RED	Flammable. Store separately only with other flammable chemicals.
BLUE	Toxic. Chemical is hazardous to health if ingested, inhaled or absorbed through the skin. Store separately in a secure area
GREEN	Reagent presents no more than a moderate hazard in any category. General chemical storage
GRAY	Used by Fisher instead of green. Reagent presents no more than a moderate hazard in any category. General chemical storage.
ORANGE	Obsolete color code, replaced by green. Reagent presents no more than a moderate hazard in any category. General chemical storage.
STRIPED	Incompatible with other reagents of the same color code. Store separately.

3.6. Chemical Security

- Laboratory supervisors must control access to their areas where chemicals are stored/used and where other hazards may be present (E.g. highly toxic chemical substances, select biological agents, radioactive materials, or potential physical hazards).
- Radioactive material must be secured from unauthorized use or removal. The Nuclear Regulatory Commission (NRC) expects that unknown or unauthorized persons encountered in the laboratory will be challenged as to their identity and intent. Persons without justification for being in the laboratory are not allowed to remain unaccompanied in the lab.

- Biological agents or toxins capable of causing serious or fatal illness to humans or animals must be maintained in a secure area designed to minimize opportunities for accidental or intentional removal of these agents.
- Controlled substances must be maintained in secure areas with physical security controls appropriate for the schedules and quantity of Controlled Substances on hand. Generally a securely locked, substantially constructed cabinet, or a safe, will provide adequate security for storage.

3.7. Chemical Transportation

- When hand-carrying chemicals place the container in a leak resistant, unbreakable secondary carrying container, bucket, or specially designed bottle carrier.
- When using a cart ensure that the cart is suitable for the load and is equipped with high edges to contain leaks or spills.
- Freight-only elevators, where available, should be used when transporting between floors.
- Compressed gas cylinders and Dewars with cryogenic liquids must be transported by themselves, by elevator (Freight-only recommended)
- Evaluate transportation methods and routes for potential risks, for example heavily populated floors or classrooms and effects of potential spills or evaporation, etc.

3.8. Chemical Container Inspection and Disposal

- Inspect stored chemicals periodically for removal of unneeded items and to detect deterioration of container integrity
- Make sure chemicals are in their proper locations.
- Remove for disposal any chemicals with leaking containers.
- Dispose of damaged containers having cracked or broken caps, chipped threads on glass or plastic bottlenecks, and/or corrosion of outer metal containers.
- Repackage or dispose of chemicals having caps indicating corrosion.
- Follow waste disposal procedures as outlined in this CHP.

3.9. Compressed Gases

- Hazardous gases such as HCl, acetylene and vinyl gases much be treated as the corrosive, flammable or the reactive chemicals that they are. They should be stored separately from “non-hazardous” gases.
- Flashback arrestors are strongly recommended for flammable gases where an open flame is used.
- Flammable gas tanks greater than 400ft3 must be electrically grounded.
- “Non-Hazardous” gases such as N2, He and Ar pose an asphyxiation hazard if a large amount of the gas is released in a quick period of time or if the work area has poor ventilation.
- All compressed gases have specific regulators. Be sure to use the correct regulator with the correct tank of gas.
- When not in use the tank should be stored with its protective cap screwed in place. Even while empty. Empty cylinders must be treated the same as full cylinders. They should be capped and secured to prevent damage that could cause problems for the next user.

- Only use a purpose built cylinder cart to move ALL gas cylinders. The risk of losing control of the cylinder and releasing the gas is too great.
- Never attempt to fill a commercial gas cylinder (E.g. Matheson Gas, Air Gas). Exceptions would include where specially constructed equipment is used for the purpose of making gas mixtures using small cylinders filled to low pressure (<500 psi).
- Full size cylinders – Must be fastened to the wall or other immovable object like a lab bench or fume hood. The chain or strap should be about one third of the way down from the top of the cylinder. This location must be away from heat sources.
- Lecture bottles – Must be in a purpose built rack or firmly clamped to a ring stand in an upright position. Never on its side or upside down.

3.10. **Cryogens (Liquefied gases and dry ice)**

- Tissue damage from frost bite or severe burns is the most common injury when working with cryogens.
- Asphyxiation from the displacement of the breathable atmosphere is of greater concern with liquefied gases than with simple compressed gases. One liter of liquid nitrogen will expand to almost 700 liters of gas. A spill of 10 liters (liquid) will create an environment in a room with less than 100m3 that would be difficult to maintain normal functions.
- Atmospheric moisture can freeze with liquid helium around the relief vent which can lead to over pressurization of the Dewar if it is unable to properly vent.
- Liquid helium can lead to oxygen enrichment. Oxygen and nitrogen in the atmosphere can condense as liquids when in the presence of liquid helium. The nitrogen evaporates at lower temperature than the oxygen causing small pockets of atmosphere with high concentrations of oxygen once it too has evaporated. Fires have been reported to have started this way.
- Liquid nitrogen can selectively condense liquid oxygen. Vacuum systems using liquid nitrogen traps should not be used to pump large quantities of atmospheric air, for fear of condensing oxygen.
- Storage vessels must be properly ventilated, pressure cannot be allowed to build up within the container.
- Only Dewars that were designed for the specific cryogen should be used.
- Liquid nitrogen and helium should be stored away from flammable materials and heat sources due to their ability to enrich oxygen.
- Never insert a hollow rod or tube into liquid gases. The liquid will quickly travel up the tube and create a fountain.

3.11. **Maintenance of Department-owned Equipment**

- All departmental-owned laboratory equipment should be maintained as per manufacturer's instructions. Routine maintenance should be performed and noted in a laboratory logbook.
- If equipment needs to be calibrated, a calibration procedure and log need to be kept with the machine. All external or factory calibration cycles should be maintained.
- Lock Out/Tag Out (LO/TO) procedures, in accordance with the University of Maine program, shall be written and implemented when a piece of equipment cannot be unplugged to perform maintenance activities.
- LO/TO procedures shall be posted or maintained near the equipment to be serviced.

- Approved LO/TO devices and tags or labels shall be used in accordance with state and federal requirements.

3.12. Unattended Operations and Working Alone

- Avoid working alone in a laboratory.
- For unattended operations, place an appropriate sign and/or warning notice on the door.
- Inform co-workers in the laboratory and associated laboratories of the nature of the experiment so that a proper response can be initiated in the event of an emergency.
- Develop departmental guidelines for those individuals required to work alone for extended periods of time. The guidelines will include appropriate contact persons and ideally itineraries for verifying the return/location of the affected employee. Also, include contact information for "buddy" systems for individuals to check on the safety of workers who may be alone in a laboratory.
- Do not work alone in a laboratory if the procedure(s) being conducted are hazardous.

3.13. Other University of Maine Programs and Policies

Where appropriate, additional programs or policies in effect at the University of Maine shall be considered or referenced within the Departmental and/or Laboratory CHP. Each of these programs is available from SM upon request. These include, but are not limited to, the following:

- Lock Out/Tag Out of Hazardous Energy Sources
- Confined Space Program
- Trenching and Excavation
- Blood borne Pathogens and Biomedical Wastes
- Use of lasers for research and/or manufacturing

Additional guidance may also be necessary with regards to waste minimization techniques and the machine guarding of laboratory equipment.

4. The Laboratory Facility: Engineered Controls, Signs and Labels, Personal Protective Equipment (PPE), and Safety Equipment

Laboratories must be equipped with engineering and administrative controls, PPE, and safety equipment suitable to the work environment and designed to protect the employees and minimize their exposure to hazardous chemicals. Supervisors must aim to minimize the storage and use of hazardous chemicals. They must also ensure that their employees are utilizing equipment and materials as designed and instructed in their SOPs/SOGs.

4.1. Engineering, Administrative Controls, PPE

- Where possible, remove and/or reduce hazardous chemicals from laboratory processes.
  - Examples include using water as a solvent or a mechanical device such as a microwave for dissolving solids.
- Re-evaluate laboratory processes often for improvements in technologies and information that aid the removal and/or reduction of hazardous chemicals.
- Substitute hazardous chemicals with less hazardous chemicals whenever possible or feasible.
- Controls to minimize exposure to hazardous chemicals must be implemented when:

  - Employees use hazardous chemicals; or
  - Employee exposures exceed the action level, or in the absence of an action level the Permissible Exposure Limit (PEL), the published exposure limit, or the Threshold Limit Value (TLV); or
  - New chemicals are added, and/or procedures are changed.
- Engineering controls are always the first line of defense in minimizing employee exposures. Examples:
  - Fume Hoods
  - Biosafety Cabinets
  - Glove Boxes
  - Machine Guards and Protective Devices
  - Noise Dampening Devices
  - Shut-off Valves/Buttons for emergency situations
- Administrative Controls (Procedures) are used when engineered controls are not adequate or cannot be instituted. These procedures include proper signage, appropriate and adequate training, managerial oversight, and documented procedures and guidelines. Examples:
  - Specific Training (SOPs/SOGs)
  - Signs, Information, and Labels
  - Employee health and area exposure monitoring
- PPE is designed for secondary employee protection from hazardous chemicals and should only be used when engineered and administrative controls cannot adequately protect the health and safety of the workers in the laboratory.

4.2. **Ventilation Systems**

General Ventilation Systems provide a source of air from outside that ventilates within the work area. An appropriate general ventilation system should be installed and constructed such that air intakes and exhausts are located to avoid the intake of contaminated air. General ventilation should continually replace laboratory air at a rate of 4-12 room air changes per hour thus preventing the increase of air concentrations of toxic substances during the workday. **Do not rely on general ventilation systems for protection from toxic substances.**

Special Ventilation Systems provide a ventilated, well enclosed work space intended to capture, contain, and exhaust harmful or dangerous fumes, vapors, and particulate matter generated by procedures conducted with hazardous chemicals or biological material. Examples include glove boxes, isolation rooms, fume hoods and biological safety cabinets.

Glove boxes and isolation rooms are used in applications where the handling of chemicals require inert or dry atmospheres such as with the use of pyrophoric materials, substances requiring special handling, or substances requiring experimental isolation. Exhaust air should be passed through scrubbers or other treatment before being released.

Refer to Appendix E: Guidance for the Use of Fume Hoods and Biological Safety Cabinets

4.3. **Ground Fault Circuit Interrupters (GFCIs**)

Ground Fault Circuit Interrupters (GFCIs**)** function by interrupting the supply of electrical power when a ground fault occurs while a piece of equipment is operated in a protected circuit (plug-outlet). These circuits (plugs-outlets) should be located in exposed electrical circuits that are within six (5) feet of a flowing water source, such as sinks, showers, etc.

4.4. **Signs, Information, and Labels**

- Emergency telephone numbers must be affixed to every telephone, i.e., 911
- “Laboratory Responsibility” signs that contain emergency numbers and appropriate emergency contacts must be posted on the external doorway to each laboratory. This information must be updated promptly when personnel change and annually.
- “Restricted Access” and areas where unusual hazards exist will include warning signs at the entranceway to the laboratory. Examples of these areas include:
    - Radioisotope usage areas
    - Biological agents present at Biosafety Level 2 or higher
    - Laser usage areas
    - Magnetic fields or electrical hazards
    - Other areas having unique or unusual hazards
- Chemical storage areas, including cabinets or shelves, containing any of the following should have the proper signage in place:
    - Carcinogens
    - Corrosives
    - Flammable Liquids
    - Biological agents present a Biosafety Level 2 or higher
- Signage should be in place to identify safety recommendations, such as “Safety Glasses Required”, and highlight locations of safety equipment including safety showers, eyewash stations, exits, and first aid equipment (if used).
- Safety Data Sheets (SDS) must be immediately available and accessible for all substances stored or used in the laboratory.
    - A system containing procedures for obtaining, filing, maintaining, and updating SDSs must be in place.
    - Chemical manufacturers or distributors are required to provide you as the purchaser an appropriate SDS for each hazardous chemical or product purchased. In many case should a SDS not accompany a purchase they can be easily obtained online.
    - Organize SDSs alphabetically and store in easily identifiable and accessible locations such as 3-ring binders or labeled file cabinets.
    - If a chemical substance is produced for another user outside of the laboratory, UMaine shall comply with the Hazard Communication Standard (29 CFR 1910.1200) including the requirements for preparing a SDS and proper labeling.
- All chemical containers must have the original or a secondary label affixed that identifies the common name (if available) and any associated hazards that are known.
    - An appropriate hazard-warning label (E.g. NFPA, HMIS) must denote all of the hazards involved. For example, a chemical that is flammable and a carcinogen must have both hazards communicated on the label.
    - Labels on incoming containers of hazardous chemicals must not be removed or defaced until the container has been emptied.
    - Replace damaged or illegible labels immediately.

- Multiple small containers can be labeled using grouping methods:
  - Legend Method
    - Label containers with abbreviated chemical name and a hazard warning;
    - Provide a key in a visible location in the lab with complete chemical name and NFPA/HMIS hazard ratings;
    - Document employee training on this alternate labeling method.
  - Box, Tray, or Shelf Method
    - Put containers in a box, tray, or specific location on shelf or cabinet;
    - Label tray, box, shelf, or cabinet with chemical name and NFPA/HMIS hazard rating;
    - Document employee training on this alternate labeling method.
- See Appendix E for guidance on Reactive and Peroxide Forming Chemicals
- See Section 5 below for Waste Disposal

4.5. Personal Protective Equipment

The need for specific PPE shall be evaluated on a case-by-case basis. The assessment will consider the presence of hazards within a work place or while performing a specific operation. At a minimum the assessment will include evaluation for the presence of overhead hazards, eye and face hazards, hand hazards, foot hazards, noise, and respiratory hazards.

Eye and Face Protection

- All eye protective devices must be impact resistant, American National Standards Institute (ANSI) approved, and worn by any individual who works inside a laboratory area.
- Eye protection must be available for visitors, who are required to wear eye protection while in the laboratory.
- Ordinary prescription glasses do not provide adequate protection against eye injury.
- Safety glasses with side shields offer minimum protection from impacts of particles, fragments, chips, etc. and can be used with low hazard chemicals and low likelihood of chemical splashes.
- Chemical splash-resistant goggles that completely enclose the area of the eyes must be worn when handling, manipulating, or transferring corrosive or extremely hazardous chemicals, where a splash hazard exists, or when indicated as necessary by existing PPE Hazard Assessments.
- Chemical splash resistant goggles and a face shield must be worn for work posing a greater than normal danger of splashing or violent reaction. Examples include working with acid baths, pouring large quantities of corrosives, handling highly reactive chemicals and working with cryogens.
- Ultra-violet (UV) light face shields must be worn when working over or under UV light sources.

Body Protection

- Wear appropriate gloves for the chemicals being handled when there is a potential for contact with toxic materials. This can be determined by referring to an SDS in conjunction with glove guides available from multiple glove manufacturers.

- Insulated gloves must be worn when handling very cold (Cryogenic gloves) or hot materials (Oven mitts). Cryogenic gloves must be made of materials that is non-porous and non-absorbent.
- Lab coats or aprons capable of deflecting spills and preventing corrosive and toxic substances from reaching the skin are required when hazardous operations involving highly toxic materials, strong acids, waste disposal, or accident cleanup are performed.

Respiratory Protection

- Respirator use is strongly discouraged and should be used ***only*** where engineering controls are not feasible or controls are being installed.
- Respirators, including paper, half- or full-face units, must be approved, issued, and monitored by SM in accordance with the UMaine Respiratory Protection Program. This program requires proper fit testing and training on proper use and care of the equipment. Depending on circumstances, medical evaluations may be required before a respirator can be issued.
- Respirators are only to be used for exposure situations that have been evaluated by a qualified person(s). Contact SM to determine whether an exposure situation warrants entry into the Respiratory Protection Program.
- Unused respirators must be removed from the workplace.
- Dust masks should only be used for protection from nuisance dust exposures.

4.6. Safety Equipment

Eye Washes

- Eye wash stations are required in all areas where the eyes may be exposed to injurious or corrosive materials.
- Eye washes must be capable of quickly drenching or flushing the eyes, readily accessible (normally 10 seconds or less), well lighted, free from obstacles, and in good working order.
- Optimally, eye washes should be activated by a quick release system that simultaneously drenches both eyes allowing the affected person to hold open their eyes and wash behind the eyelids.
- Laboratories equipped with eye wash stations within their work area are required to inspect and keep a log of the function of their eye wash stations weekly. The tester will verify that the eye wash is:
  - free of obstructions and easily visible
  - easily activated
  - provides adequate water pressure and flow
  - provides water that is clean and tepid in temperature
  - has no damaged or broken parts

Safety Showers

- Required in all areas where injurious or corrosive materials are used
- Must be clearly marked, capable of quickly drenching the affected person, readily accessible (normally located within 100 feet or less), well lighted, free from obstacles, and in good working order.
- Inspection and flushing should occur periodically.

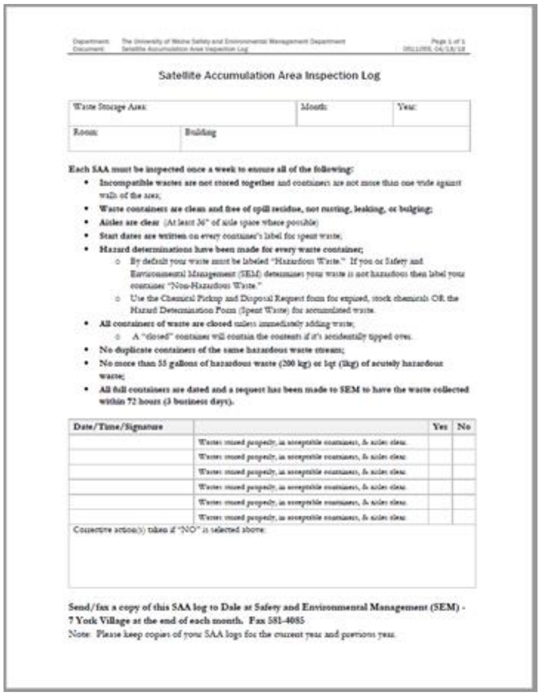
Fire Extinguishers and First Aid Kits

- Fire extinguishers are to be used only by persons holding current (within last 3 years), hands-on training.
- Fire extinguishers must be available, charged and hung in a location that is immediately accessible; no obstructions should be present that might inhibit the use of this equipment.
- Each extinguisher should be inspected annually and will contain a tag indicating the date of the last inspection.
- First Aid Kits must be checked and re-supplied every six (6) months.

5. Waste Disposal

The disposal of chemical waste is highly regulated by the Environmental Protection Agency (EPA) and Maine Department of Environmental Protection (MDEP). Most chemicals will be collected and will have to comply with the conditions below. Your campus Safety Contact/Coordinator will assist you in determining:

- How to store and manage your waste
    - Orono, FBRI in Old Town, South Portland and DMC campuses are designated as large quantity generators (LGQs) for the State of Maine and must manage Satellite Accumulation Areas (SAA). The most recent SAA log can be located in Safety Managements web page under "SM Documents," then "Forms."(See picture below)
    - All other campuses are designated as small quantity generators (SQGs) and should follow the UMS "Hazardous Waste Management at Remote Sites" Guidance (Page 1 of 7 shown below)
- What is and is not hazardous waste
    - Hazardous waste includes chemicals that are expired, unwanted, or spent (used in a process) and have one or more characteristics that make them flammable, corrosive, reactive, toxic, and environmentally harmful.



Satellite Accumulation Area Inspection Log

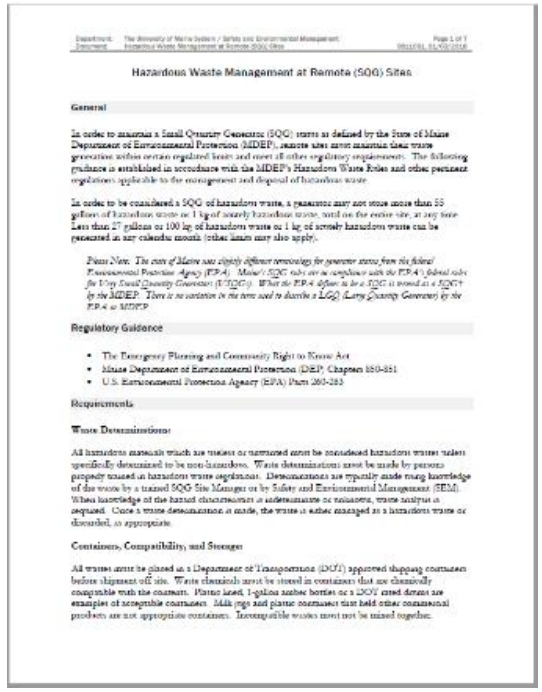
Waste Storage Area:		Month:	Year:
Room:	Building:		

Each SAA must be inspected once a week to ensure all of the following:

- **Incompatible wastes are not stored together** and containers are not more than one wide against walls of the area;
- **Waste containers are clean and free of spill residue, not rusting, leaking, or bulging;**
- **Aisles are clear** (At least 36" of aisle space where possible)
- **Start dates are written** on every container's label for spent waste;
- **Hazard determinations have been made for every waste container;**
    - By default your waste must be labeled "Hazardous Waste." If you or Safety and Environmental Management (SEM) determines your waste is not hazardous then label your container "Non-Hazardous Waste."
    - Use the Chemical Pickup and Disposal Request form for expired, stock chemicals OR the Hazard Determination Form (Spent Waste) for accumulated waste.
- **All containers of waste are closed** unless immediately adding waste;
    - A "closed" container will contain the contents if it's accidentally tipped over.
- **No duplicate containers of the same hazardous waste stream;**
- **No more than 55 gallons of hazardous waste (200 kg) or 1qt (1kg) of acutely hazardous waste;**
- **All full containers are dated and a request has been made to SEM to have the waste collected within 72 hours (3 business days).**

Date/Time/Signature		Yes	No
	Wastes stored properly, in acceptable containers, & aisles clear.		
	Wastes stored properly, in acceptable containers, & aisles clear.		
	Wastes stored properly, in acceptable containers, & aisles clear.		
	Wastes stored properly, in acceptable containers, & aisles clear.		
	Wastes stored properly, in acceptable containers, & aisles clear.		
	Wastes stored properly, in acceptable containers, & aisles clear.		
Corrective action(s) taken if "NO" is selected above:			

Send/fax a copy of this SAA log to Dale at Safety and Environmental Management (SEM) - 7 York Village at the end of each month. Fax 581-4085
Note: Please keep copies of your SAA logs for the current year and previous year.



Hazardous Waste Management at Remote (SQG) Sites

General

In order to maintain a Small Quantity Generator (SQG) status as defined by the State of Maine Department of Environmental Protection (MDEP), remote sites must maintain their waste generation within certain regulated limits and meet all other regulatory requirements. The following guidance is established in accordance with the MDEP's Hazardous Waste Rules and other pertinent regulations applicable to the management and disposal of hazardous waste.

In order to be considered a SQG of hazardous waste, a generator may not store more than 55 gallons of hazardous waste or 1 kg of acutely hazardous waste, total on the entire site, at any time. Less than 27 gallons or 100 kg of hazardous waste or 1 kg of acutely hazardous waste can be generated in any calendar month (other limits may also apply).

Please Note: The state of Maine uses slightly different terminology for generator status from the federal Environmental Protection Agency (EPA). Maine's SQG rules are in compliance with the EPA's federal rules for Very Small Quantity Generators (VSQG's). What the EPA defines to be a SQG is treated as a SQG+ by the MDEP. There is no variation in the term used to describe a LQG (Large Quantity Generator) by the EPA or MDEP.

Regulatory Guidance

- The Emergency Planning and Community Right to Know Act
- Maine Department of Environmental Protection (DEP) Chapters 850-851
- U.S. Environmental Protection Agency (EPA) Parts 260-283

Requirements

Waste Determinations:

All hazardous materials which are useless or unwanted must be considered hazardous wastes unless specifically determined to be non-hazardous. Waste determinations must be made by persons properly trained in hazardous waste regulations. Determinations are typically made using knowledge of the waste by a trained SQG Site Manager or by Safety and Environmental Management (SEM). When knowledge of the hazard characteristics is indeterminate or unknown, waste analysis is required. Once a waste determination is made, the waste is either managed as a hazardous waste or discarded, as appropriate.

Containers, Compatibility, and Storage:

All wastes must be placed in a Department of Transportation (DOT) approved shipping container before shipment off site. Waste chemicals must be stored in containers that are chemically compatible with the contents. Plastic lined, 1-gallon amber bottles or a DOT rated drums are examples of acceptable containers. Milk jugs and plastic containers that held other commercial products are not appropriate containers. Incompatible wastes must not be mixed together.

5.1. Neutralization and Non-Hazardous Waste

- Acids and Bases that are free of heavy metals and toxic products resulting from neutralization may be neutralized and flushed down to the sewer (500ml).
    - Generally sodium bicarbonate is used to neutralize acids and citric acid is used to neutralize bases. However, a dilute solution of sodium hydroxide or hydrochloric acid may also be used.
    - Neutralization should occur such that the resulting pH of the product solution is around 7.0 +/- .5.
    - It is recommended that neutralization reactions are done in a fume hood.
- Aqueous salt solutions may be disposed of into the sewer if they do NOT contain heavy metals or toxic anions.
- Empty containers previously containing nonhazardous waste can be disposed of in the normal garbage collection but the previous contents should be blackened out

5.2. Biological Waste

Laboratories generating biological waste must follow the University of Maine Biomedical Waste Management Plan found on the Safety Managements web page under "SM Documents," then "Policies," then "Waste Management."

5.3. Hazardous Waste

Hazardous waste includes stock chemicals with

- Hazardous waste must be stored in a designated area with sign.
- Segregate containers of incompatible waste (e. g. acids & bases)
- All waste must be kept in secondary containment and incompatible waste must be stored in separate secondary containment.

- All containers must remain sealed, unless there is a potential danger of gas formation. Containers requiring off gassing may be placed within secondary containment inside a chemical fume hood with the cap loosened.
- All waste must be properly labeled "Hazardous Waste" or "Nonhazardous Waste "and have the generators name and all contents listed. Labels may be created or purchase. A sheet with Hazardous Waste labels on them that can be printed, can be found on the University of Maine System, Safety Management (SM) web page under "SM Documents," then "Forms."

- Hazardous waste must be dated with a start and full date.
- Full containers within SAA's (LQG sites) must be removed from the storage area and transported by SM to a central accumulation area within 72 hours (3 business days). Full containers for SQG sites must be removed off site by a licensed transporter within 180 days.
- All SAA waste storage areas (LQG sites) must be inspected weekly. SQG central accumulation areas are required to perform monthly inspections.
- Disposal of unknown items can be done but it is strongly discouraged as the cost for disposal is higher.

6. Standard Operating Procedures/Guidelines (SOPs/SOGs) for Working with Hazardous Materials or Processes in the Laboratory

Below are some guidelines to follow for developing a SOP/SOG and before beginning to work with hazardous chemicals or processes. For each task involving the potential for toxic exposures or physical injury from hazardous materials, the investigator or laboratory supervisor must complete a Work Place Hazard Assessment and Personal Protective Equipment Certification Form. Additionally, special precautions, engineering and administrative controls, PPE assessments and emergency procedures must all be incorporated.

6.1. Hazard Assessment and Preparation

- Consult SDSs to determine whether the materials and/or processes you will be working with pose any special hazards and what engineered controls are necessary for the safe handling, storage and disposal of the hazardous material.
- Evaluate engineering and administrative controls that will minimize the exposure to hazardous substances.
- Complete a Work Place Hazard Assessment and Personal Protective Equipment Certification Form.
- Incorporate Emergency Procedures
- Incorporate Decontamination/Clean up Procedures
- Verify that all required signs, information, and labels are in place, as applicable, for the hazards encountered with the materials.

- Tasks involving similar hazards may be grouped together on a single assessment form.

6.2. Working with Particularly Hazardous Substances: Provisions for Select Carcinogens, Reproductive Toxins, and Acutely Toxic Chemicals

Employee exposures to Particularly Hazardous Substances (PHS') must be kept as low as reasonably achievable, and at a minimum, the lower of the following two values must not be exceeded **(Consult the applicable SDS and contact SM to determine the appropriate exposure levels and for help interpreting the values)**:

- The *Permissible Exposure Limits (PELs)*, which represent Time Weighted Averages (TWAs) in parts per million (ppm) or milligrams of substance per cubic meter of air (mg/m^3). The TWA represents the ratio between exposure and work shift. The Occupational Safety and Health Administration (OSHA) establishes these values for a wide range of chemicals. In most cases the value can be found on the SDS and Safety Management can aid the interpretation of the value.
- The American Conference of Governmental Industrial Hygienists (ACGIH) has established *Threshold Limit Values (TLVs),* which are TWA values similar to PELs.

Some categories of hazards require Investigators to notify SM before a laboratory worker begins using a hazardous material and/or process. The Investigator must determine if the hazard is sufficient to warrant this notification. Examples include, but are not limited to:

- Acutely Toxic Substances, prior to first use, or if procedures or quantities used change;
- Chronically Toxic Substances, prior to first use, or if procedures or quantities used change;
- Reproductive Toxins, prior to first use, or if procedures or quantities used change; or
- Select Carcinogens, prior to first use, or if procedures or quantities used change.

Work involving any of the above substances must conform to the following requirements:

- Quantities of particularly hazardous substances used and stored in the laboratory, including solutions or mixtures, should be minimized.
- Maintain accurate records of the amounts of particularly hazardous substances stored and used, the dates of use, and names of users.
- When performing work with particularly hazardous substances that might release chemical vapors or dust and have a TLV or PEL of 50 ppm or lower, use a properly functioning fume hood, ventilated glove box, sealed system, or other system designed to minimize exposures to the substances. **Released vapors of acutely toxic particularly hazardous substances may require scrubbing or trapping to prevent discharge with the fume hood exhaust.**
- Special Precautions
  - Always avoid skin contact by using proper PPE as outlined in the PPE Hazard Assessment for the work to be conducted.
  - Guard against spills and splashes and utilize proper containment devices:
    - Store substances, properly labeled, in an adequately ventilated, limited access area in properly labeled, unbreakable, chemically resistant, secondary containers.
    - Store breakable containers in chemical resistant trays.
    - Work and mount apparatus above chemical resistant trays and/or cover work and storage surfaces with removable, absorbent, plastic backed paper.

    - Notify supervisors of all incidents of exposure or spills.
    - The laboratory supervisor must prepare emergency response procedures for releases or spills of particularly hazardous substances and the written information must be included in the Area Specific Emergency Action Plan.
  - Ensure that essential engineered controls such as fume hoods and glove boxes are operating properly before beginning work.
  - Keep volatile substances cool and contained.
  - Dispersive solids should be kept in closed containers and in locations with minimal air currents.
  - Gas cylinders containing toxic gases should have properly functioning valves, check valves, regulators, containment capable of withstanding pressure build up, and appropriate piping.
  - Utilize detection equipment in laboratories where highly toxic substances, for example toxic gases, are used.

- Establish a Designated Work Area
  - Designate an entire laboratory, an area of the laboratory, or a device such as a fume hood or ventilated glove box for the purpose of working with particularly hazardous substances.
  - Mark the area with appropriate signage warning of the hazard in the area.
  - Label all containers and storage properly.
  - Training
    - Assure that all laboratory workers with access to the designated work area are aware of necessary safety precautions.
    - For laboratory workers who have access to the designated area, training is required even for those who do not work with the substance.
    - Recognition of the signs and symptoms of exposure to the substances must be part of training for all workers with access to the designated work area.
    - Laboratory workers using the substances must receive training on safe handling and storage.
    - Laboratory workers and others in the building who may be affected by spills and releases of particularly hazardous substances must receive training on emergency response procedures.
    - The laboratory supervisor is responsible for coordinating all required training.
  - Contaminated Waste
    - Store contaminated waste in closed, properly labeled, impervious containers.
    - Collect and dispose of wastes promptly and properly
  - Decontamination and Housekeeping
    - Upon completing work in or leaving a designated work area, remove any protective apparel (placing it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck.
    - Where possible, chemically decontaminate by chemical conversion within the experimental protocol to a less toxic substance thus minimizing health hazards and the amount of waste.
    - 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.

- Use a wet mop or a vacuum cleaner equipped with a HEPA filter. DO NOT dry sweep powders of particularly hazardous substances.

7. Emergency Planning and Response, Spills, Medical Emergencies, and Accidents

The Emergency Action Plan is here to guide you on what to do in the event of an emergency in **[Building].** The emergency evacuation alarm consists of horns and strobe lights, and is sounded from pull stations near the exits and stairs or automatically by heat sensors in the ceilings of each room and corridor. If it sounds, follow the exit pathways toward the rally point **[location of rally point].** Exit Pathways are posted in laboratories and in the corridors. In general use the nearest pathway that leads out of the building. Fire doors may be used to egress out of a building but should remain closed at all times. Fire doors prevent (or slow down) the spread of smoke and fire within a building. During inclement weather (rain, snow and excessive cold) the shelter in place location is **[add the location here]**.

[Attach a copy/picture(s) of the departments evacuation map(s) here if desired]

Emergency Phone Contacts: **[Fill in the Contact Names and Phone Numbers Below]**
- Police and Fire Dispatch: 911
- Other Contacts (E.g. Facilities, Department members, Assembly Area Coordinator, etc.)

7.1. Fire Emergencies

- The individual discovering the fire must activate the nearest fire alarm pull station as they exit the building and proceed to the rally point.
- Portable fire extinguishers should not be used unless the individual is assigned to use one and has had fire extinguisher training within the past 3 years.
- If a fire is in a fume hood, and it can be done safely, close the sash before evacuating.

7.2. Chemical Spill Emergencies

Chemical spills may or may not be emergencies depending upon a variety of factors. If the spill is an emergency (outside help is required) do not attempt a cleanup! Report the incident to the University police department or by dialing 911 from a campus phone. Note: If you have a cell phone, placing your campuses police department phone number in your phone contacts is recommended.

Spills constituting an emergency include the following situations:
- The spill is in a public area such as stairwells, corridors or lobbies.
- A spill kit and personal protective equipment are not present.
- The material spilled is not known.
- The spill is more than a spill kit can handle.
- You are uncertain of how to handle the spill and faculty/staff or not nearby to assist.

If a chemical is spilled on you:

- Use the emergency shower or eyewash station, rinsing the affected area for at least 15 minutes. Important: Some water reactive chemicals should not be cleaned in a shower. Separate decontamination procedures should be established. Please ensure that you read the SDS and understand a chemical's properties before using it.
- Loudly alert others around you to the spill
- Have nearby help contact emergency responders at 911 if the injuries are serious.
- Seek immediate medical attention.

If someone else is the victim of the spill:

- Contact emergency responders at 911 if the injuries are serious.
- Loudly alert others to the spill.
- DO NOT attempt first aid unless you have had trained in the past 2 years and you have the appropriate personal protective equipment.

If no one is involved in the spill

- Close any doors.
- Loudly alert others to the spill.
- Find a safe location outside of the work area and wait for emergency responders to arrive.

7.3. **Spill Kits for Non-Emergency Chemical Spills**

Every laboratory must have a stocked spill kit. Each member of the laboratory should know the location of the kit and be trained on how to use it before starting work. A five gallon pail with a tight fitting lid can be used to hold the following material:

- Absorbent, such as cat litter or Speedi Dri, enough to fill the container and handle a spill of 4L of liquid.
- A heavy duty plastic bag to contain absorbed waste.
- A black marker to identify the waste collected in the plastic bag
- Neutralizing materials like Sodium Bicarbonate for acids or Citric Acid for bases.
- Decontamination supplies such as detergent.
- Chemical Waste labels to identify the contents of the spill.
- Each lab should also consider anything additional that would be special to their needs. Example: Sulfur powder for Mercury spills.

7.4. **Personal Injury Emergencies**

- For all personal injuries call for help. Contact the University police department or dial 911 (or ask someone to do this for you).
- When speaking to emergency responders follow their instructions of the dispatcher.
- Do NOT attempt first aid unless you have a current first aid certification and you have Personal Protective Equipment at your disposal, especially gloves and goggles.
- Unless you have received training from SM to clean biohazard spills, do not attempt to clean the fluids (E.g. blood) by yourself and prevent others from going near the area.

All injuries must be reported to the University Risk Management Department. Guidance can be found on SM's web page, look under "FAQ", then "How do I Report an Injury." There is a link that will take you to Risk Managements web page where forms can be found. An investigation will be conducted to determine what measures need to be implemented to prevent the accident or injury from happening again.

7.5. Emergency Equipment

Eyewash Station

- Identify the location of the flushing eyewash station nearest your work space and be familiar with how to turn it on. Most use a simple lever to start the water flow.
- If you experience a splash or other exposure to your eyes loudly shout for assistance and proceed to the eye wash station.
- Holding your eyes open, flush them for 15 minutes. The water may be cold but this amount of time is necessary to flush away as much of the contaminant as possible.

Safety Shower

- Identify the location of the safety shower nearest your work space and be familiar with how to turn it on. Most use a handle that is pulled underneath the shower cone.
- The shower can be used for clothing fires as well as chemical exposures.
- If you are splashed or otherwise exposed, loudly shout for assistance and proceed to the shower. Note: You should utilize separate established procedures for removing contamination involving water reactive chemicals.
- Flush the contaminants off for at least 15 minutes. Remove your lab coats and other personal protective equipment and possibly your outer layer of clothing. There is no time for modesty especially with very corrosive or flammable chemicals.
- Dial 911 to seek immediate medical attention.
- If you assist someone, your own personal protective equipment may become contaminated and will have to be dealt with appropriately.

Pull Stations

- These will activate the building emergency lights and sirens.
- Pull stations are located next to stairways and exits for ease of use while exiting the building in an emergency.
- These red boxes can be activated by pulling the little red circle that says "Pull."
- Some of these stations will have a metal guard in place to prevent accidental activation. Simply lift the guard and then pull the circle.
- Fire Extinguishers are located throughout the building to assist those trained in their use to put out small fires. All others must evacuate.

7.6. Additional Department Requirements

- Mechanisms or processes for reporting all accidents, spills and "near-misses" to the supervisor. The potential for these incidents should be carefully considered and documented within a departments SOPs/SOGs and shared with all staff.
- Methods for the communicating the departmental Emergency Action Plan (such as; evacuation, medical care, blood-borne pathogens awareness, reporting and emergency drills);

- Laboratory specific emergency procedures for working in laboratories (i.e.: communication and evacuation for buildings, use of emergency equipment such as alarm pull stations, eyewashes, emergency showers, spill kits, etc.);
- Procedures for working under special circumstances (i.e.: cold rooms, growth chambers, individuals working alone, handling particularly hazardous materials such as hydrofluoric acid, etc.)

Note: Occasionally a fume hood alarm may be activated due to insufficient ventilation. This does not present an emergency. The sound of a hood alarm is localized to the room where the hood is and does not activate the fire alarm system which can be heard at a much louder volume throughout the building. Close the sash to the fume hood and place a sign on the sash (a piece of masking tape and a marker will work) notifying users not to use. A work order will need to be placed through Facilities Maintenance to have this fume hood repaired.

8. Medical Program: Exposure Assessment and Medical Consultation

8.1. Exposure Assessment and Monitoring

- **Initial Assessment and Monitoring**
  - For laboratory uses of OSHA regulated substances, the Principal Laboratory Investigator will work with SM to assess and perform monitoring as determined to be appropriate and to evaluate if individual exposures to such substances exceed the Permissible Exposure Limits (PELs) specified in 29 CFR 1910 Subpart Z.
  - Use of appropriate engineering controls may eliminate the need for assessment in certain circumstances.
  - Assessment or sampling may be determined to be necessary for certain processes prior to or during laboratory renovation or redesign activities.

- ***Periodic Monitoring*** will be conducted at appropriate time intervals if the initial assessment discloses individual exposures over the action level or the PEL.

- ***Exposure Assessments*** may be conducted to determine if:
  - An employee could possibly be exposed to a hazardous chemical in a manner that might cause harm.
    - Those research-generated materials that have a potential to exceed a PEL
  - There was an exposure that might have caused harm to occupationally exposed individuals and to determine the chemical(s) involved.
    - These exposure assessments are only to determine the facts of a particular incident and do not make recommendations for on-going or future actions.

- ***Potential Overexposures*** warrant additional inquiry and an exposure assessment should be conducted if any or all of the following conditions are present:
  - An individual manifests symptoms such as headache, rash, nausea, coughing, tearing, irritation or redness of the eyes, irritation of the nose or throat, dizziness, loss of motor dexterity or judgment, etc., and:

        - Some or all of the symptoms disappear when the individual is removed from the exposure area; and
        - The symptoms reappear soon after the employee returns to work with the same hazardous chemicals.
    - When multiple persons in the same laboratory work area have similar complaints.
    - A hazardous chemical leaked, spilled or was otherwise rapidly released in an uncontrolled manner.
    - An individual had direct contact with a hazardous chemical.

- **Employee Notification**
    - Within fifteen (15) working days after the receipt of any monitoring results, the Department of Human Resources will notify the individual of monitoring results in writing either individually or by posting results in an appropriate location that is accessible to affected individuals.
    - Interpretation of monitoring results shall be provided to the individual as part of the notification process.

8.2. Medical Consultations and Examinations

- **Purpose**
    - The purpose of a medical consultation is to determine whether a medical examination is warranted.
    - When assessment results indicate that an employee may have been exposed to a hazardous chemical:
        - The employee will have the opportunity (and is encouraged) to obtain a medical consultation under the direct supervision of a licensed physician; and
        - If the consultation indicates that a medical examination is needed, the employee will be provided an opportunity to see a licensed physician who has experience in treating victims of chemical overexposure.
    - Details of the consultation, examination, any tests, and follow-up are determined by the physician and are considered confidential.
    - Examinations must be under the direct supervision of a licensed physician and must be at no cost to the employee.

- **Communication and Information**
    - The University will consult the Principal Laboratory Investigator or other person thoroughly familiar with the conditions of employee exposure before medical consultations or examinations are scheduled.
    - Information for baseline evaluations will be based on the job descriptions, chemical exposures, chemical inventories, and any other relevant information that is available to all parties.
    - Once a baseline determination has been made, the physician will work with the Office of Human Resources to establish medical baseline requirements.
    - In the event of a potential overexposure, the Principal Laboratory Investigator or other responsible party must provide the physician with the following information:
        - The known or identifiable components of the hazardous chemical(s) to which the individual may have been exposed;

    - A description of the condition under which the exposure occurred including quantitative exposure data, if available; and
    - A description of the signs and symptoms of exposure that the employee is experiencing, if any.

- **Access to Medical Information**
  - The University will provide all individuals who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations that the examining physician determines to be necessary, under the following circumstances:
    - Whenever an individual develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory;
    - Where exposure assessment reveals an exposure level routinely above the action level or the PEL for an OSHA regulated substance; or
    - 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.

- **Physician**
  - All medical consultations and examinations will be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay, and at a reasonable time and place.
  - For consultation or examination under this standard, the Office of Human Resources will obtain a written opinion from the examining physician that includes the following:
    - Any recommendation of further medical follow-up;
    - The results of the medical examination and any associated tests;
    - Any medical condition that may be revealed in the course of the examination that may place the employee at increased risk as a result of exposure to a hazardous workplace; and
    - 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.
  - Results of medical consultations or examinations will be considered confidential information. The written physician's opinion will not reveal specific findings of diagnoses unrelated to occupational exposure.

Appendix A – Definitions

"Action level": A concentration, designated in 29 CFR 1910 Subpart Z for specific substances, calculated as an eight (8) hour time-weighted average, which initiates certain required activities such as, engineering controls, administrative controls, periodic exposure monitoring and medical surveillance. An Action Level shall not apply to chemicals that do not have a designated valued listed in Subpart Z, or for research generated chemicals or unknowns that do not have established exposure limits. For these chemicals, all procedures where objective data indicates a reasonably anticipated potential for exposure, the previously stated control measures shall be instituted.

"Administrative Controls" are methods of controlling or reducing employee exposure(s), which incorporate, but are not limited to, one or more of the following control options;

1. Standard Operating Procedures;
2. Training and Education;
3. Modified Work Practices;
4. Job Rotation;
5. Air Sampling;
6. Improved Personal Hygiene;
7. Biological Sampling or Medical Surveillance Programs;
8. Maintenance of Laboratory Equipment; and/or
9. Facilities Maintenance of Laboratory Space.

"Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

"Carcinogen" (see "select carcinogen").

"Chemical Hygiene Officer" means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

"Chemical Hygiene Plan" means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that (1) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (2) meets the requirements of paragraph (e) of this section.

"Combustible liquid" means any liquid having a flashpoint at or above 100 deg. F. (37.8 deg. C), but below 200 deg. F (93.3 deg. C), except any mixture having components with flashpoints of 200 deg. F (93.3deg. C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

"Compressed gas" means:

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

2. A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 deg. F (54.4 deg. C) regardless of the pressure at 70 deg. F (21.1 deg. C); or
3. A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 deg C) as determined by ASTM D-323-72.

"Corrosivity" means an aqueous acid solution with a pH less than or equal to 2.0, an aqueous base solution with a pH greater than or equal to 12.5, a chemical capable of causing destruction of human tissue, or liquids which corrode steel or aluminum at a rate of 0.25 inches or more per year at 130□ F (55□ C) or a solid which may exhibit corrosive properties when mixed with water.

"Designated area" means an area which may be used for work with "select carcinogens," reproductive toxins or substances which have a high degree of acute or chronic toxicity, whether a known or a potential hazard. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

"Engineering Controls" are methods of controlling or reducing employee exposure(s), which incorporate, but are not limited to, one or more of the following control options:
1. Process change, such as paint dipping instead of paint spraying;
2. Source Substitution or Modification, e.g., histologists may substitute limonene-based tissue fixative for xylene;
3. Process or Source Isolation, such as control rooms to physically separate the worker from the hazard; or
4. Mechanical Ventilation, such as dilution or local exhaust designed to draw source vapors, gases, or particulates away from the breathing zone of the worker.

"Emergency" is a situation, actual or imminent, including incidents, accidents or conditions, which, if left uncorrected may result in injury, loss of life, damage to buildings, or situations which present an immediate safety hazard or security risk. Note: A situation is not an emergency if corrective employees in the immediate area can take measures; it does not pose an increased health and safety risk beyond those normally associated with the laboratory; and, employees have the proper equipment and training to deal with the situation.

"Employee" (see "Occupational Exposed Individuals" or "Potentially Exposed Individuals")

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

"Field Laboratory" is a remote site, vessel, vehicle or station where chemical, and possible physical, hazards are present. This includes, but is not limited to motorized and non-motorized boats, field stations, transportation vehicles and aircraft, field trips and on-site sampling.

"Flammable" means a chemical that falls into one of the following categories:
1. Aerosol, flammable" means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;
2. "Gas, flammable" means (A) a gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or (B) a

gas that, at ambient temperature and pressure, forms a range of flammable mixtures in air greater than 12 percent by volume, regardless of the lower limit.

3. "Liquid, flammable" means any liquid having a flashpoint below 100 deg F (37.8 deg. C), except any mixture having components with flashpoints of 100 deg. C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.
4. "Solid, flammable" means a solid, other than a blasting agent or explosive as defined in 1910.109 (a), that is liable to cause fire through friction, absorption or moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

"Flashpoint" means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

1. Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24-1979 (ASTM D 56-79) - for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 deg. F (37.8 deg. C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or
2. Pensky-Martens Closed Tester (See American National Standard method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D 93-79) - for liquids with a viscosity equal to or greater than 45 SUS at 100 deg. F (378 deg. C), or that contain suspended solids, or that have a tendency to form a surface film under test; or
3. Setaflash Closed Tester (see American National Standard Method of Test for Flash Point by Setaflash Closed Tester (ASTM D 3278 -78)).

NOTE: Organic peroxides, which undergo auto-accelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

"Hazardous Chemical" is a known substance or mixture of substances which, under certain circumstances, poses a significant risk to laboratory workers owing to acute or chronic toxicity, flammability, corrosivity or explosivity; or which exhibits health or physical hazard properties as defined in 1910.1200, subpart A. Exemption: a hazardous chemical does not include substances which provide no potential for employee exposure such as procedures using chemically impregnated test media and commercially prepared test kits, nor does this apply to uses of hazardous chemicals which do not meet the definition of laboratory scale, even if that use occurs in a laboratory.

"Highly Hazardous Chemical" is a hazardous chemical that has the potential for causing lethal or crippling injuries under normal conditions within a university or laboratory setting.

"Laboratory" is a facility in which one or more of the following definitions are met:

1. Any building or a room inside a building where the use of chemicals defined as hazardous occurs. These include, but are not limited to, teaching facilities, darkrooms, art studios and research facilities.
2. Any permanent remote site where the use of chemicals defined as hazardous occurs. Examples are farms, permanent field stations and permanent experiment stations.

3. Any building or room inside a building where physical hazards, associated with the use of hazardous chemicals, are present. This includes teaching and research facilities, but excludes sites such as; machine shops, print shops, janitorial closets and laboratories (where only physical hazards and no chemical hazards are present in the judgment of EH&S), live animal research facilities, offices and lecture classrooms.

"Laboratory scale" Laboratory scale manipulations shall be considered those processes where the minimum required quantity of a hazardous chemical are used to perform a planned chemical manipulation. This process shall follow guidelines for research protocols and be designed for analysis or research. Processes in which a product is generated for uses other than analytical or research needs (e.g. for sale or distribution to other laboratories or industries) shall not be considered "laboratory scale";

"Laboratory-type hood" is a device located in a laboratory, enclosed on five sides, with a movable sash or fixed partial enclosure on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms. Laboratory-type hoods may include the following:

1. Conventional or Standard Chemical Fume Hood which controls the pattern of air movement through the hood and sash across the hood entrance to an exhaust in the top or the back;
2. By-pass Chemical Fume Hood which operates as a conventional hood except when closed and then allows air to enter through a bypass grille located above the sash;
3. Auxiliary Air Chemical Fume Hood which supplies an air plenum outside the hood at the top of the face opening; or,
4. Variable Air Volume (VAV) Chemical Fume Hood, which allows the exhaust volume to be varied by changing the speed of the exhaust blower in the ductwork.
5. Biosafety Cabinets (BSCs) for use with biological agents and pathogenic microorganisms; where the unit is exhausted to the outside

"Laboratory Ventilation Devices" may exist in addition to, or instead of, a Laboratory-type hood. These include, but are not limited to:

1. Biosafety Cabinets (BSCs) for use with biological agents and pathogenic microorganisms;
2. Canopy Hoods used for non-hazardous exhaust operations;
3. Elephant Trunks or Snorkels used for capturing emissions from gas chromatographs, spectrophotometric equipment or other specific laboratory devices;
4. Glove Boxes with tight-closing doors or air locks in arm holes with impervious gloves at negative pressure;
5. Laminar Flow Cabinets that incorporate directional flow of air to capture and carry away airborne particles;
6. Slot Hoods designed to capture contaminants in industrial applications; and,
7. Table top hoods with small, spot ventilation that is normally vented downward through the tabletop.
8. California Hoods with moveable sashes on more than one side;
9. Distillation Hoods for use with distillation apparatus;
10. A Ductless Hood that filters the exhaust air and returns it directly to the laboratory space;

11. Perchloric Acid Hoods with a by-pass type of hood constructed with a water wash system so it is safe for use with Perchloric acid or other reagents that might form flammable or explosive compounds in contact with organic construction materials;
12. Radioisotope Hood that provides interior work surfaces that are impervious and easy to decontaminate; or,
13. Walk-in Hood designed to be floor-mounted with sash and/or doors for closing the open face.

"Laboratory use of hazardous chemicals" refers to the handling or use of hazardous or potentially hazardous chemical in which the following conditions are met:

1. Chemical manipulations are carried out on a "laboratory scale".
2. Multiple chemical procedures or chemicals are used;
3. The procedures involved are not part of a "production process". A production process shall be defined as a process in which the resultant or desired end product is produced in a quantity greater than that needed to sufficiently test or analyze the process in question. Simulation of actual manufacturing procedures for the sole purpose of developing, testing or evaluation a specific process or procedure, regardless of scale, shall not be considered as a "production process";
4. A hazard assessment has been performed for the specific process and a detailed Standard Operating Procedure (SOP) has been developed for the process. Based upon the assessment, protective laboratory practices and equipment are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

"Medical Consultation" is a consultation, which takes place between an employee and a licensed physician for the purpose of determining what medical examination, or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place. If an over exposure is suspected, an exposure assessment is necessary. If an assessment indicates that an employee could reasonably have been exposed to a hazardous chemical in a manner that might have caused harm, the victim is entitled to a medical consultation and, if determined in the consultation, to a medical examination at no cost to the employee.

"Occupational Exposed Individuals" are those individuals or students who, during the course of performing tasks related to their occupation or education are, or potentially may be, subject to exposure to hazardous or potentially hazardous chemical or physical hazards which may negatively impact an individual's health or well-being.

"Organic peroxide" means an organic compound which contains the bivalent -O-O structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic group, or substituent.

"Oxidizer" means a chemical other than a blasting agent or explosive as defined in 1910.109 (a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

"Research-Generated Sample" includes a substance or mixture of substances generated for purposes of laboratory research or testing by: (1) extraction from plants, animals, or environmental sources; or (2) a chemical reaction or sequence of reactions performed on other substances. The exact composition of the sample and the potential hazards associated with it may or may not be known, and indeed, may be the object of the research to be carried out with the sample.

"Physical Hazard" means any existing or potential condition in the laboratory that by itself, or by interacting with other variables, can result in deaths, injuries, property damage or other losses. These conditions include, but are not limited to:

1. A chemical for which there is a reasonable expectation that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, shock sensitive, ignition hazard, or water-reactive;
2. Compressed gases, under positive pressure, which could lead to a rupture of the tank or valve;
3. Thermal hazards, which can cause contact tissue damage from extreme heat or cold, or high-pressure reactions when warmed in a sealed vessel. These may include cryogenic sources from super conducting magnets, vacuum lines or technical research equipment, or burns from heat sources, furnaces and autoclaves.
4. Pressure hazards from hydraulic, pneumatic or chemical sources, which operate at elevated, pressures above one atmosphere or under a vacuum and have the potential of implosion or explosion.
5. Glass and other laboratory equipment which can easily be broken; and other relevant housekeeping or fire safety concerns.

"Potentially Exposed Individuals" are persons who do not directly work with hazardous, or potentially hazardous, chemicals or physical agents but may be exposed indirectly (e.g.: working in an adjacent office, custodial/maintenance workers, etc.) during the performance of their occupation or education. Visitors, students, or other people not specifically employed by the University shall also be considered indirectly exposed if their activities result in the potential contact with hazardous or potentially hazardous chemical or physical agents.

"Protective laboratory practices and equipment" means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

"Reactive" means a chemical having low activation energy for combination with some other chemical substance. This reaction requires two separate substances for a reaction to take place.

"Reproductive hazard" means chemicals that affect the reproductive chemicals, which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

"Select carcinogen" means any substance, which meets one of the following criteria:

1. It is regulated by OSHA as a carcinogen; or,
2. It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or,
3. It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC) (latest editions); or,
4. It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

a. After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m (3);
b. After repeated skin application of less than 300 (mg/kg of body weight) per week; or,
c. After oral dosages of less than 50 mg/kg of body weight per day.

"Significant Exposure" means an acute or chronic exposure to hazardous, or potentially hazardous, chemicals or physical agents at or above the conservative limits established by OSHA or the American Conference of Governmental Industrial Hygienists (ACGIH). Where there is a potential to cause health impairments or where symptoms of ill health are exhibited at concentrations below established limits, an evaluation shall be made of the nature and physical characteristics of the agent(s) and the sensitivity of the individual and the potential to cause health impacts. Based upon this evaluation and comparisons of TLVs of similar (chemically and physically) acting agents, similar classes of chemicals, the known properties of the chemical and the circumstances of exposure, a threshold value shall be established and implemented.

"Toxicity" means a substance which can have an adverse effect on a plant, animal or human based on the dose, length of exposure, route of entry and reactive properties. Toxicity may be determined by the type of exposure: acute (single exposure) or chronic (multiple exposures); or the mutagenic (capable of causing genetic mutations or chromosomal damage), teratogenic (capable of causing anatomical or biochemical effects on a developing fetus) or carcinogenic (capable of causing cancer in animals or humans) effects.

"Unstable" means a chemical which has high energy relative to the elements from which it is formed and requiring a low activation energy to decompose toward these elements.

"Water-reactive" means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

Appendix B – Safety Data Sheet and Hazard Pictogram Information

The follow describes the 16 sections found in a SDS:

Section 1: Identification - This section identifies the chemical on the SDS as well as the recommended uses. It also provides the essential contact information of the supplier.

Section 2: Hazard(s) Identification - This section identifies the hazards of the chemical presented on the SDS and the appropriate warning information associated with those hazards.

Section 3: Composition - This section identifies the ingredient(s) contained in the product indicated on the SDS. This section includes information on substances, mixtures, and all chemicals where a trade secret is claimed.

Section 4: First-Aid - This section describes the initial care that should be given by untrained responders to an individual who has been exposed to the chemical.

Section 5: Fire-Fighting - This section provides recommendations for fighting a fire caused by the chemical.

Section 6: Accidental Release - This section provides recommendations on the appropriate response to spills, leaks, or releases, including containment and cleanup practices to prevent or minimize exposure to people, properties, or the environment. It may also include recommendations distinguishing between responses for large and small spills where the spill volume has a significant impact on the hazard.

Section 7: Handling and Storage - This section provides guidance on the safe handling practices and conditions for safe storage of chemicals.

Section 8: Exposure Controls - This section indicates the exposure limits, engineering controls, and personal protective measures that can be used to minimize worker exposure.

Section 9: Physical and Chemical Properties - This section identifies physical and chemical properties associated with the substance or mixture.

Section 10: Stability and Reactivity - This section describes the reactivity hazards of the chemical and the chemical stability information. This section is broken into three parts: reactivity, chemical stability, and other.

Section 11: Toxicological Information - This section identifies toxicological and health effects information or indicates that such data are not available.

Section 12: Ecological Information - This section provides information to evaluate the environmental impact of the chemical(s) if it were released to the environment.

Section 13: Disposal Considerations - This section provides guidance on proper disposal practices, recycling or reclamation of the chemical(s) or its container, and safe handling practices.

Section 14: Transport Information - This section provides guidance on classification information for shipping and transporting of hazardous chemical(s) by road, air, rail, or sea.

Section 15: Regulatory Information - This section identifies the safety, health, and environmental regulations specific for the product that is not indicated anywhere else on the SDS.

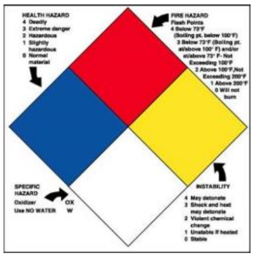
Section 16: Other Information - This section indicates when the SDS was prepared or when the last known revision was made. The SDS may also state where the changes have been made to the previous version. You may wish to contact the supplier for an explanation of the changes. Other useful information also may be included here.

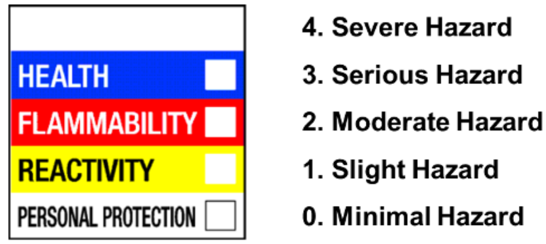
Hazard Pictograms

Pictograms are universally recognized pictures that communicate a hazard. There are 9 types and they can be found on the container's label as well as in the SDS (usually section 2). These pictograms should serve as a warning to examine the SDS and consult any SOPs that exist before working with the material.

 Explosive	 Flammable	 Oxidizer	 Compressed Gas	 Corrosive
 Acutely Toxicity	 Other Hazard	 Health Hazard	 Environmental Hazard	

Commonly used in older SDSs (but may still be used) is the National Fire Protection Association (NFPA) Hazard Diamond and the HMIS Label. Blue represents a health hazard, red a fire hazard (flammability), yellow represents reactivity, and white provide specific hazard information (e.g. ~~W~~ means keep away from water). Numbers are provided in the blue, red and yellow squares to indicate severity with 4 being the most hazardous and 0 being the least.





Appendix C – Substances Requiring Special Attention

The following list is not intended to be all-inclusive:

Acetylenic compounds, both organic and inorganic (especially heavy metal salts), can be explosive and shock sensitive. At pressures of 2 atm or greater and moderate temperature, acetylene (C2H2) has been reported to decompose explosively, even in the absence of air. Because of these dangers, acetylene must be handled in acetone solution and never stored alone in a cylinder.

Alkyllithium compounds are highly reactive and pyrophoric. Violent reactions may occur on exposure to water, carbon dioxide, and other materials. They are also highly corrosive to the skin and eyes. Tert-Butyllithium solutions are the most pyrophoric and may ignite spontaneously on exposure to air. Contact with water or moist materials can lead to fires and explosions. These compounds should be stored and handled under an inert atmosphere in areas that are free from ignition sources.

Aluminum chloride (AlCl3) should be considered a potentially dangerous material. If moisture is present, sufficient decomposition may form hydrogen chloride (HCl) and build up considerable pressure. If a bottle is to be opened after long storage, it should first be completely enclosed in a heavy towel.

Ammonia and amines. Ammonia (NH3) reacts with iodine to give nitrogen triiodide, which explodes on touch. Ammonia reacts with hypochlorites (bleach) to give chlorine. Mixtures of ammonia and organic halides sometimes react violently when heated under pressure. Ammonia is combustible. Inhalation of concentrated fumes can be fatal. Ammonia and amines can react with heavy metal salts to produce explosive fulminates.

Azides, both organic and inorganic, and some azo compounds can be heat and shock sensitive. Azides such as sodium azide can displace halide from chlorinated hydrocarbons such as dichloromethane to form highly explosive organic polyazides; this substitution reaction is facilitated in solvents such as dimethyl sulfoxide.

Boron trifluoride and boron trichloride (BF3 and BCl3, respectively) react with water to give HF and HCl, respectively. Their fumes are corrosive, toxic, and irritating to the eyes and mucous membranes.

Carbon disulfide (CS2) is both very toxic and very flammable; mixed with air, its vapors can be ignited by a steam bath or pipe, a hot plate, or a lightbulb.

Chlorine (C12) is highly toxic and may react violently with hydrogen (H2) or with hydrocarbons when exposed to sunlight.

Chlorine trifluoride (ClF3) in liquid form is corrosive and very toxic. It is a potential source of explosion and causes deep penetrating burns on contact with the body. The effect may be delayed and progressive, as in the case of burns caused by hydrogen fluoride. Chlorine trifluoride reacts vigorously with water and most oxidizable substances at room temperature, frequently with immediate ignition. It reacts with most metals and metal oxides at elevated temperatures. In addition, it reacts with silicon-containing compounds and thus can support the continued combustion of glass, asbestos, and other such materials. Chlorine trifluoride forms explosive mixtures with water vapor, ammonia, hydrogen, and most organic vapors.

Diazomethane (CH_2N_2) and related diazo compounds should be treated with extreme caution. They are very toxic, and the pure gases and liquids explode readily even from contact with sharp edges of glass. Solutions in ether are safer from this standpoint. An ether solution of diazomethane is rendered harmless by dropwise addition of acetic acid.

Diethyl and other ethers, including tetrahydrofuran and 1,4-dioxane and particularly the branched-chain type of ethers, may contain peroxides that have developed from air autoxidation. Concentration of these peroxides during distillation may lead to explosion. Ferrous salts or sodium bisulfite can be used to decompose these peroxides, and passage over basic active alumina can remove most of the peroxidic material. In general, however, dispose of old samples of ethers if they test positive test for peroxide.

Diisopropyl ether is a notoriously dangerous, Class A peroxide former. The peroxide is not completely soluble in the mother liquor. Peroxide concentrations from autoxidation may form saturated solutions that then crystallize the peroxide as it is being formed. There are numerous reports of old bottles of diisopropyl ether being found with large masses of crystals settled at the bottom of the bottle. These crystals are extremely shock sensitive, even while wetted with the diisopropyl ether supernatant. Mild shock (e.g., bottle breakage, removing the bottle cap) is sufficient to result in explosion. This ether should not be stored in the laboratory. Only the amount required for a particular experiment or process should be purchased; any leftover material should be disposed of immediately.

Dimethyl sulfoxide (DMSO), $(CH_3)_2SO$, decomposes violently on contact with a wide variety of active halogen compounds, such as acyl chlorides. Explosions from contact with active metal hydrides have been reported. DMSO does penetrate and carry dissolved substances through the skin membrane.
Dry benzoyl peroxide $(C_6H_5CO_2)_2$ is easily ignited and sensitive to shock. It decomposes spontaneously at temperatures greater than 50 °C. It is reported to be desensitized by addition of 20% water.

Dusts that are suspensions of oxidizable particles (e.g., magnesium powder, zinc dust, carbon powder, and flowers of sulfur) in the air can constitute powerful explosive mixtures. These materials should be used with adequate ventilation and should not be exposed to ignition sources. When finely divided, some solids, including zirconium, titanium, Raney nickel, lead (such as prepared by pyrolysis of lead tartrate), and catalysts (such as activated carbon containing active metals and hydrogen), can combust spontaneously if allowed to dry while exposed to air and should be handled wet.

Ethylene oxide (C_2H_4O) has been known to explode when heated in a closed vessel. Experiments using ethylene oxide under pressure should be carried out behind suitable barricades.

Fluorine (F_2) is an extremely toxic reactive oxidizing gas with extremely low permissible exposure levels. Only trained personnel should be authorized to work with fluorine. (See Vignette 6.4.)

Anyone planning to work with fluorine must be knowledgeable of proper first-aid treatment and have the necessary supplies on hand before beginning.

Halogenated compounds, such as chloroform ($CHCl_3$), carbon tetrachloride (CC14), and other halogenated solvents, should not be dried with sodium, potassium, or other active metals; violent explosions usually result. Many halogenated compounds are toxic. Oxidized halogen compounds—chlorates, chlorites, bromates, and iodates—and the corresponding peroxy compounds may be explosive at high temperatures.

Hydrogen fluoride and hydrogen fluoride generators. Anhydrous HF or hydrogen fluoride is a colorless liquid that boils at 19.5 ºC. It has a pungent irritating odor, and a time-weighted average exposure of 3 ppm for routine work. Aqueous HF is a colorless very corrosive liquid that fumes at concentrations greater than 48%. It attacks glass, concrete, and some metals, especially cast iron and alloys containing silica as well as organic materials such as leather, natural rubber, wood, and human tissue. Although HF is nonflammable, its corrosive action on metals can result in the formation of hydrogen in containers and piping, creating a fire and explosion hazard. HF should be stored in tightly closed polyethylene containers. HF attacks glass and therefore should never be stored in a glass container. HF causes severe injury via skin and eye contact, inhalation, and ingestion. It is very aggressive physiologically because the fluoride ion readily penetrates the skin and may cause decalcification of the bones and systemic toxicity, including pulmonary edema, cardiac arrhythmia and death. Burns from HF may not be painful or visible for several hours and even moderate exposure to concentrated HF can result in fatality.

Hydrogen peroxide (H_2O_2) stronger than 3% can be dangerous; in contact with skin, it causes severe burns. Thirty percent H_2O_2 may decompose violently if contaminated with iron, copper, chromium, or other metals or their salts. Stirring bars may inadvertently bring metal into a reaction and should be used with caution.

Hydrogen selenide (H_2Se) is a colorless gas with an offensive odor. It is a dangerous fire and explosion risk and reacts violently with oxidizing materials. Hydrogen selenide is an irritant to eyes, mucous membranes, and the pulmonary system. Acute exposures can cause symptoms such as pulmonary edema, severe bronchitis, and bronchial pneumonia. Symptoms also include gastrointestinal distress, dizziness, increased fatigue, and a metallic taste in the mouth.

Hydrogen sulfide (H_2S) is a highly toxic and flammable gas. Although it has a characteristic odor of rotten eggs, it fatigues the sense of smell. This could result in failure to notice the seriousness of the situation before health becomes at risk and is problematic for rescuers who think danger has passed when the odor disappears.

Liquid nitrogen–cooled traps open to the atmosphere condense liquid air rapidly. When the coolant is removed, an explosive pressure buildup occurs, usually with enough force to shatter glass equipment if the system has been closed. Hence, only sealed or evacuated equipment should be so cooled. Vacuum traps must not be left under static vacuum; liquid nitrogen in Dewar flasks must be removed from these traps when the vacuum pumps are turned off.

Lithium aluminum hydride ($LiAlH_4$) should not be used as a drying agent for solvents that are hygroscopic and may contain high concentrations of water, such as methyl ethers and tetrahydrofuran; fires from reaction with damp ethers are often observed. Predrying these solvents with a less efficient drying agent, followed by $LiAlH_4$ treatment is recommended. The reaction of $LiAlH_4$ with carbon dioxide has reportedly generated explosive products. Carbon dioxide or bicarbonate extinguishers should not be used for $LiAlH_4$ fires; instead, such fires should be smothered with sand or some other inert substance.

Methyl chloride (CH_3Cl) has a slight, not unpleasant, odor that is not irritating and may pass unnoticed unless a warning agent has been added. Exposure to excessive concentrations is indicated by symptoms similar to those of alcohol intoxication, that is, drowsiness, mental confusion, nausea, and possibly vomiting. Methyl chloride may, under certain conditions, react with aluminum or magnesium to form materials that ignite or fume spontaneously with air, and contact with these metals should be avoided.

Nitric acid is a strong acid, very corrosive, and decomposes to produce nitrogen oxides. The fumes are very irritating, and inhalation may cause pulmonary edema. Nitric acid is also a powerful oxidant and reacts violently, sometimes explosively reducing agents (e.g., organic compounds) with liberation of toxic nitrogen oxides. Contact with organic matter must be avoided. Extreme caution must be taken when cleaning glassware contaminated with organic solvents or material with nitric acid. Toxic fumes of NO_x are generated and explosion may occur.

Nitrate, nitro, and nitroso compounds may be explosive, especially if more than one of these groups is present in the molecule. Alcohols and polyols may form highly explosive nitrate esters (e.g., nitroglycerine) from reaction with nitric acid.

Organometallics may be hazardous because some organometallic compounds burn vigorously on contact with air or moisture. For example, solutions of tert-Butyllithium ignite some organic solvents on exposure to air. The pertinent information should be obtained for a specific compound.

Oxygen tanks should be handled with care because serious explosions have resulted from contact between oil and high-pressure oxygen. Oil or grease should not be used on connections to an O_2 cylinder or gas line carrying O_2.

Ozone (O_3) is a highly reactive toxic gas. It is formed by the action of ultraviolet light on oxygen (air), and therefore certain ultraviolet sources may require venting to the exhaust hood. Ozonides can be explosive.

Palladium (Pd) or platinum (Pt) on carbon, platinum oxide, Raney nickel, and other catalysts presents the danger of explosion if additional catalyst is added to a flask in which an air-flammable vapor mixture or hydrogen is present. The use of flammable filter paper should be avoided.

Perchlorates should be avoided whenever possible. Perchlorate salts of organic, organometallic, and inorganic cations are potentially explosive and may detonate by heat or shock. Whenever possible, perchlorate should be replaced with safer anions such as fluoroborate, fluorophosphates, and trifluoromethanesulfonate (triflate). Special $HClO_4$ hoods with integrated wash systems must be used when working with these salts.

Permanganates are explosive when treated with sulfuric acid. If both compounds are used in an absorption train, an empty trap should be placed between them and monitored for entrapment.

Peroxides (inorganic) should be handled carefully. When mixed with combustible materials, barium, sodium, and potassium peroxides form explosives that ignite easily.

Phenol is a corrosive and moderately toxic substance that affects the central nervous system and can cause damage to the liver and kidneys. Phenol-formaldehyde reactions are used in creation of phenolic resins, and can be highly exothermic. These reactions have been implicated in a number of plant-scale accidents when runaway reactions caused a sudden rise in pressure and rupturing of pressure disks or vessels. Care should be taken if performing such reactions in the laboratory.

Phosphine (PH3) is a spontaneously flammable and explosive poisonous colorless gas with the foul odor of decaying fish. The liquid can cause frostbite. Phosphine is a dangerous fire hazard and ignites in the presence of air and oxidizers. It reacts with water, acids, and halogens. If heated, it forms hydrogen phosphides, which are explosive and toxic. There may be a delay between exposure and the appearance of symptoms.

Phosphorus (P) (red and white) forms explosive mixtures with oxidizing agents. White phosphorus should be stored underwater because it ignites spontaneously in air. The reaction of phosphorus with aqueous hydroxides gives phosphine, which is toxic and also may either ignite spontaneously or explode in air.

Phosphorus trichloride (PCl3) reacts with water to form phosphorous acid with HCl evolution; the phosphorous acid decomposes on heating to form phosphine, which may either ignite spontaneously or explode. Care should be taken in opening containers of PCl3, and samples that have been exposed to moisture should not be heated without adequate shielding to protect the operator.

Piranha solution is a mixture of concentrated sulfuric acid and 30% hydrogen peroxide. It is a powerful oxidant and strong acid used to remove organic residues from various surfaces. Many instances of explosions have been reported with this solution upon contact with reducing agents, especially organics. The solution slowly evolves oxygen, and therefore containers must be vented at all times.

Potassium (K) is much more reactive than sodium; it ignites quickly on exposure to humid air, and therefore should be handled under the surface of a hydrocarbon solvent such as mineral oil or toluene. Potassium can form a crust of the superoxide (KO2) or the hydrated hydroxide (KOH·H2O) on contact with air. If this happens, the act of cutting a surface crust off the metal or of melting the encrusted metal can cause a severe explosion due to oxidation of the organic oil or solvent by superoxide, or from reaction of the potassium with water liberated from the hydrated hydroxide.

Silane (SiH4) is a pyrophoric colorless gas that ignites spontaneously in air. It is incompatible with water, bases, oxidizers, and halogens. The gas has a choking repulsive odor. Silyl halides are toxic colorless gases with a pungent odor. They are corrosive irritants to the skin, eyes, and mucous membranes. When silyl halides are heated, toxic fumes can be emitted.

Sodium (Na) should be stored in a closed container under kerosene, toluene, or mineral oil. Scraps of sodium or potassium should be destroyed by reaction with n-butyl alcohol. Contact with water should be avoided because sodium reacts violently with water to form hydrogen (H2) with evolution of sufficient heat to cause ignition. Carbon dioxide, bicarbonate, and carbon tetrachloride fire extinguishers should not be used on alkali metal fires.

Sodium amide (NaNH2) can undergo oxidation on exposure to air to give sodium nitrite in a mixture that is unstable and may explode.

Sulfuric acid (H2SO4) should be avoided, if possible, as a drying agent in desiccators. If it must be used, glass beads should be placed in it to help prevent splashing when the desiccator is moved. To dilute H2SO4, the acid should be added slowly to cold water. Addition of water to the denser H2SO4 can cause localized surface boiling and spattering on the operator.

Trichloroethylene (Cl2CCHCl) reacts under a variety of conditions with potassium or sodium hydroxide to form dichloroacetylene, which ignites spontaneously in air and explodes readily even at dry-ice temperatures. The compound itself is highly toxic, and suitable precautions should be taken when it is used.

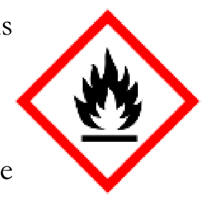
Appendix D– Reactive and Peroxide Forming Chemicals

The following information provides supplementary guidance for the handling and testing of reactive and peroxide forming chemicals. Basic information on the hazards associated with various kinds of reactive chemicals is included along with a list of chemicals that require special attention. Where and when applicable, this information should be provided for all users. Always refer to a chemicals safety data sheet and supplier instructions for the proper use and storage of reactive and peroxide forming chemicals!

Water Reactives:

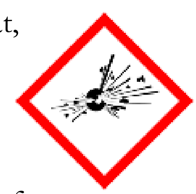
Water-reactive materials are those that react violently with water. Alkali metals (e.g., lithium, sodium, and potassium), many organometallic compounds, and some hydrides react with water to produce heat and flammable hydrogen gas, which ignites or combines explosively with atmospheric oxygen. Some anhydrous metal halides (e.g., aluminum bromide), oxides (e.g., calcium oxide), nonmetal oxides (e.g., sulfur trioxide), and halides (e.g., phosphorus pentachloride) react exothermically with water, resulting in a violent reaction if there is insufficient coolant water to dissipate the heat produced.

Pyrophorics:



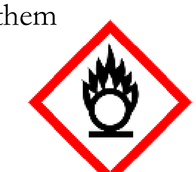
For pyrophoric materials, oxidation of the compound by oxygen or moisture in air proceeds so rapidly that ignition occurs. Many finely divided metals are pyrophoric, and their degree of reactivity depends on particle size, as well as factors such as the presence of moisture and the thermodynamics of metal oxide or metal nitride formation. Other reducing agents, such as metal hydrides, alloys of reactive metals, low-valent metal salts, and iron sulfides, are also pyrophoric.

Explosives:



An explosive is any chemical compound or mechanical mixture that, when subjected to heat, impact, friction, detonation, or other suitable initiation, undergoes rapid chemical change, evolving large volumes of gases that exert pressure on the surrounding medium. The term applies to materials that either detonate or deflagrate. Heat, light, mechanical shock, and certain catalysts initiate explosive reactions. Hydrogen and chlorine react explosively in the presence of light. Acids, bases, and other substances catalyze the explosive polymerization of acrolein, and many metal ions can catalyze the violent decomposition of hydrogen peroxide. Shock-sensitive materials include acetylides, azides, nitrogen triiodide, organic nitrates, nitro compounds, perchlorate salts (especially those of heavy metals such as ruthenium and osmium), many organic peroxides, and compounds containing diazo, halamine, nitroso, and ozonide functional groups. See appendix A for a list of functional groups found in some explosive compounds.

Organic Peroxides



Organic peroxides are a special class of compounds with unusually low stability that makes them among the most hazardous substances commonly handled in laboratories, especially as initiators for free-radical reactions. Although they are low-power explosives, they are hazardous because of their extreme sensitivity to shock, sparks, and other forms of accidental detonation. Many peroxides that are used routinely in laboratories are far more sensitive to shock than most primary explosives (e.g., TNT), although many have been stabilized by the addition of compounds that inhibit reaction. Nevertheless, even low rates of decomposition may automatically accelerate and cause a violent explosion, especially in bulk quantities of peroxides (e.g., benzoyl peroxide). These compounds are sensitive to heat, friction, impact, and light, as well as to strong oxidizing and reducing agents. All organic peroxides are highly flammable, and fires involving bulk quantities of peroxides should be approached with extreme caution.

Oxidizers:
Oxidizing agents may react violently when they come into contact with reducing materials and sometimes with ordinary combustibles. Such oxidizing agents include halogens, chromates, and functional groups with additional oxygen in their formula indicated by the use of the prefix "per" in the compounds name. Perchloric acid is a powerful oxidizing agent with organic compounds and other reducing agents. Perchlorate salts are explosive and should be treated as potentially hazardous compounds. Some common oxidants are as follows:

- **Gases:** chlorine, fluorine, nitrous oxide, oxygen, ozone, steam
- **Liquids:** bromide, hydrogen peroxide, nitric acid, perchloric acid, sulfuric acid
- **Solids:** bromates, chlorates, chlorites, chromates, dichromates, hypochlorites, iodates, nitrates, nitrites, perchlorates, persulfates, peroxides, permanganates, picrates

Peroxidizables:
Certain common laboratory chemicals form peroxides on exposure to oxygen in air. Over time, some chemicals continue to build peroxides to potentially dangerous levels, whereas others accumulate a relatively low equilibrium concentration of peroxide, which becomes dangerous only after being concentrated by evaporation or distillation. The peroxide becomes concentrated (application of heat and subsequent evaporation) because it is less volatile than the parent chemical. A related class of compounds includes inhibitor-free monomers (a monomer is a basic chemical unit/molecule that makes up a polymer; example: glucose is a monomer of cellulose) prone to free radical polymerization that on exposure to air can form peroxides or other free radical sources capable of initiating violent polymerization. Note that care must be taken when storing and using these monomers - most of the inhibitors used to stabilize these compounds require the presence of oxygen to function properly. Excluding oxygen by storing potential peroxide formers under an inert atmosphere (N2 or argon) greatly increases their safe storage lifetime. Purchasing the chemical stored under nitrogen in septum-capped bottles is also possible. In some cases, stabilizers or inhibitors (free-radical scavengers that terminate the chain reaction) are added to the liquid to extend its storage lifetime. Because distillation of the stabilized liquid removes the stabilizer, the distillate must be stored with care and monitored for peroxide formation.

Precautions for handling peroxides:

- Limit the quantity of peroxide forming chemicals to the minimum amount required. Do not return unused quantities to the original container. All inventories should be kept to a minimum and managed on a first in-first out basis.
- Clean up all spills immediately. Solutions of peroxides can be absorbed on vermiculite or other absorbing material. Contact your local campus Safety Contact/Coordinator to have this material collected as hazardous waste.
- Reduce the sensitivity of most peroxides to shock and heat by dilution with inert solvents, such as aliphatic hydrocarbons (straight chained, single or double bonded C-H compounds).

However, do not use aromatics (such as toluene), which are known to induce the decomposition of diacyl peroxides.

- Do not use solutions of peroxides in volatile solvents under conditions in which the solvent might vaporize because this will increase the peroxide concentration in the solution.
- Do not use metal spatulas to handle peroxides because contamination by metals can lead to explosive decomposition. Magnetic stirring bars can unintentionally introduce iron, which can initiate an explosive reaction of peroxides. Ceramic, Teflon, or wooden spatulas and stirring blades may be used if it is known that the material is not shock sensitive.
- Do not permit open flames and other sources of heat near peroxides. It is important to label areas that contain peroxides so that this hazard is evident.
- Avoid friction, grinding, and all forms of impact near peroxides, especially solid peroxides. Glass containers that have screw-cap lids or glass stoppers should not be used. Polyethylene bottles that have screw-cap lids may be used.
- To minimize the rate of decomposition, store peroxides at the lowest possible temperature consistent with their solubility or freezing point. Do not store liquid peroxides or solutions at or lower than the temperature at which the peroxide freezes or precipitates because peroxides in these forms are extremely sensitive to shock and heat.
- If possible (transparent containers), visually check the consistency of any liquids. Arrange for the disposal of any chemicals that are suspected show evidence of peroxide formation either from the precipitation of crystals or the appearance of "strings" with in the homogeneity of the solution.
- Do not attempt to open peroxide forming chemicals beyond their expiration dates! Some compounds can be deadly when peroxidized, and the act of unscrewing a cap or dropping a bottle can be enough to trigger an explosion. Contact your local campus Safety Contact/Coordinator to have this material collected as hazardous waste.

Labeling and Testing
All bottles of peroxide forming chemicals should be dated with the date they are opened. Peroxide test strips are relatively inexpensive and may be purchased from a number of vendors online. Test strips purchased should be low range (E.g. 0-25ppm). When tested, the date of test and the results should also be written on bottle. Alternatively tape or a premade label may be used so long as it doesn't interfere with the bottles primary label. Chemicals that show evidence of peroxide formers should be closely monitored. Arrangements for disposal should be made for chemicals with test results approaching 10ppm or greater. Bottles should be disposed of in a timely manner by either the guidance listed in the tables below or by the expiration date on the containers label. Please notify UMS Safety Management of the test results when arrangements for pick up and disposal are made.

Peroxide Classes: A, B, C

Class A compounds are especially dangerous when peroxidized and should not be stored for long periods in the laboratory. Good practice requires they be discarded within 3 months of receipt. Testing is not recommended. If a container of a Class A peroxidizable is past its expiration date, or if the presence of peroxides is suspected or proven, do not attempt to open the container!

Class A: Chemicals that form explosive levels of peroxides without concentration – Discard within 3 months
Isopropyl ether
Butadiene
Chlorobutadiene (chloroprene)
Potassium amide
Potassium metal
Sodium amide (sodamide)
Tetrafluoroethylene
Divinyl acetylene
Vinylidene chloride

Class B materials are often sold with autoxidation inhibitors. If the inhibitor is removed, or if inhibitor-free material is purchased, particular care must be taken in their long-term storage because of the enhanced probability of peroxide formation. Purging the container headspace with nitrogen is recommended. No special disposal precautions are required for peroxide-contaminated Class B materials.

Class B: Chemicals forming peroxide hazards on concentration. Class B materials should be stored in a dark location. If stored in glass bottles, the glass should be amber. Containers should be marked with their opening date and inspected/tested every 6 months thereafter. Discard after 12 months.
Acetal
Cumene
Cyclohexene
Cyclooctene
Cyclopentene
Diaacetylene
Dicyclopentadiene
Diethylene glycol dimethyl ether (diglyme)
Diethyl ether
Dioxane (p-dioxane)
Ethylene glycol dimethyl ether (glyme)
Furan
Methyl acetylene
Methyl cyclopentane
Methyl-isobutyl ketone
Tetrahydrofuran
Tetrahydronapthalene
Vinyl ethers

In most cases, commercial samples of **Class C materials** are provided with polymerization inhibitors that require the presence of oxygen to function and therefore are not to be stored under inert atmosphere. Inhibitor-free samples of Class C compounds (i.e., the compound has been synthesized in the laboratory or the inhibitor has been removed from the commercial sample) should be kept in the smallest quantities required and under inert atmosphere. Unused material should be properly disposed of immediately, or if long-term storage is necessary, an appropriate inhibitor should be added.

Class C: Unsaturated monomers that may autopolymerize as a result of peroxide accumulation if inhibitors have been removed or are depleted. Class C materials should be stored in a dark location. If stored in glass bottles, the glass should be amber. Containers should be marked with their opening date and inspected every 6 months thereafter. Without inhibitor, chemicals should be used within 5 days upon receipt and discarded within 24 hours upon opening. Inhibitor added - Discard after 12 months
Acrylic acid
Butadiene
Chlorotrifluoroethylene
Ethyl acrylate
Methyl methacrylate
Styrene
Vinyl acetate
Vinyl chloride
Vinyl pyridine

Determining Reaction Quantities

When a possibly hazardous reaction is attempted, small quantities of reactants should be used. When handling highly reactive chemicals, use the smallest quantities needed for the experiment. In conventional explosives laboratories, no more than 0.1 g of product should be prepared in a single run. During the actual reaction period, no more than 0.5 g of reactants should be present in the reaction vessel: The diluent, the substrate, and the energetic reactant must all be considered when determining the total explosive power of the reaction mixture. Special formal risk assessments should be established to examine operational and safety problems involved in scaling up a reaction in which an explosive substance is used or could be generated.

Conducting Reaction Operations

The most common heating devices are heating tapes and mantles and sand, water, steam, wax, silicone oil, and air (or nitrogen) baths. They should be used in such a way that if an explosion were to occur the heating medium would be contained. Heating baths should consist of nonflammable materials. All controls for heating and stirring equipment should be operable from outside the shielded area. Vacuum pumps should carry tags indicating the date of the most recent oil change. Oil should be changed once a month, or sooner if it is known that the oil has been unintentionally exposed to reactive gases. All pumps should be either vented into a hood or trapped. Vent lines may be Tygon, rubber, or copper. If Tygon or rubber lines are used, they should be supported so that they do not sag and cause a trap for condensed liquids.

Appendix E – Guidance for the Use of Fume Hoods and Biological Safety Cabinets

The Proper Use of a Fume Hood

Purpose
A fume hood is a ventilation device that protects its users from open containers of volatile liquids and solid particulates by removing gases, fumes and airborne dusts and exhausting them outside of your building.

How a fume hood works
A fume hood basically consists of a large metal box with a see through sash that can be raised and lowered, a flat work surface inside, a baffle directing air to an exhaust plenum, air flow gauge and/or alarm, and exhaust fan unit. The fan unit is connected to the exhaust ducting and directs air inside the fume hood out of the building. The baffle's opening can be adjusted by our Facility Maintenance (FM) workers to modify air flow. The sash allows you to see what you're doing with your arms and hands behind a protective barrier while allowing air to flow from the room into the hood. The air flow gauge (if equipped) and alarm lets you know that air is flowing into the hood from the room and if it's sufficient (not in alarm).

Using your fume hood
1. All fume hoods must be inspected annually. This is performed by Safety Management. A yellow inspection sticker can be located somewhere on the outside of the hood with a due date. The due date should be after today's date. If inspection is past due, then do not use the hood and notify Safety Management via email at sem@maine.edu or phone at 581-4055.
2. Turn on your hood (if it's not already running) and raise the sash to its full opening. Let the hood run for about a minute while you're performing steps 3-8. Initially, the hood may alarm as the fan unit gets started. Silence the alarm and wait until the air flow gauge remains steady (if equipped) and the alarm light turns off. *Note: Fume hoods that also store Satellite Accumulation Area waste may be left on continuously.*
3. Never use a fume hood that stays in alarm. This indicates that air flow may not be sufficient. Close the sash to the fume hood and place a sign on the sash (a piece of masking tape and a marker will work) notifying users not to use. A work order will need to be placed through Facilities Maintenance to have this fume hood repaired.
4. Visually check the inside and outside of the fume hood for physical damage or missing parts. Report discrepancies to your work area manager. He/she may place a work order with FM to request repairs.
5. Place only the chemicals and materials you want to work with inside the hood. Avoid clutter in the fume hood as this can affect air flow.
6. Lower your sash to its appropriate working height. This is about 15". You should see

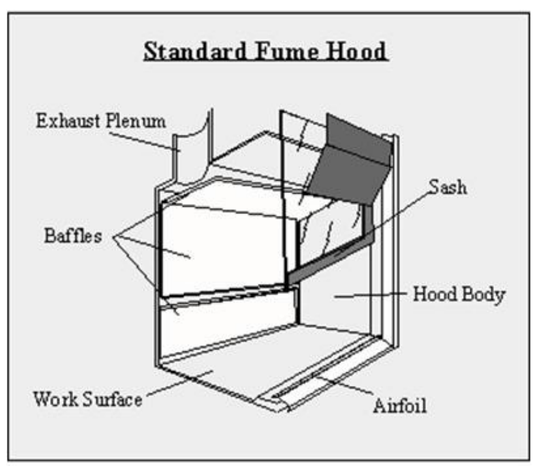


Figure 1 Basic features of a standard fume hood.

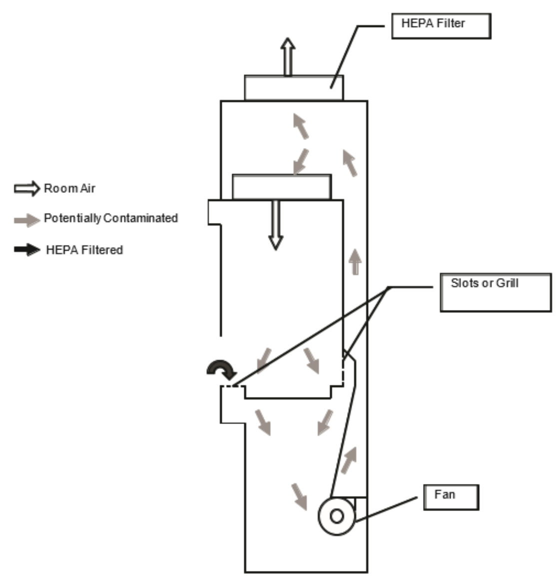
arrows or markings on the front sides of the hood guiding to where the bottom of the sash should line up with.

7. Using a piece of tissue paper or "Kimwipe," hold it in front of the sashes opening and make sure air is flowing into the hood by doing the following: Starting from the left side, measure air flow top, middle, then bottom. Repeat at the center of the sash's opening and then again on the right side. The paper should bend towards and into the sashes opening. Notify your work area manager of any discrepancies.
8. You are ready to perform work in the fume hood. *REMEMBER: NEVER insert your head or torso into the fume hood at any time while performing work with a fume hood!*
9. After you are finished using the hood, return chemicals and materials back to their storage areas and clean up the work surface for the next user. Turn off the hood (if it was off to begin with) and close the slash if no one else intends on using it.

The Proper Use of a Biological Safety Cabinet (BSC)

Introduction

BSCs are common containment and protection devices used in laboratories working with biological agents. BSCs and other facilities in which biological hazards are handled require special construction and operating procedures to protect laboratory personnel and the environment. A BSC is generally not suited for work with hazardous volatile chemicals because their HEPA filters will not contain gases, fumes, or vapors. Such work must be done in a fume hood. Likewise, a fume hood is not adequately designed to contain biological material.



How a biological safety cabinet works

There are three classes of BSCs. The University of Maine primarily uses Class II biosafety cabinets which provide a clean work environment and protection to the user. Internal supply air passes through a HEPA (High Efficiency Particulate Arresting) filter in a downward laminar flow across the work surface, preventing cross contamination. It works by drawing room air around laboratory personnel through slots in the work surface at the front of the cabinet, offering user protection. Air also is exhausted through a grill along the back of the cabinet and is either recirculated through HEPA filters to the internal workspace or passes through another set of filters to be exhausted to the room or through ductwork and out of the building.

Using your BSC

10. A BSC requires recertification annually (includes filter change as required). A recertification sticker will be located on the outside of the cabinet with a due date. If recertification is past due, then do not use the hood. **Orono Only: Contact Doreen F Sanborn, Molecular & Biomedical Science, Hitchner Hall, Administrative Specialist CL2, (207) 581-281, doreen@maine.edu to schedule recertification.**

11. Turn the cabinet on at least 10–l5 minutes prior to use, if the cabinet is not left running. Verify the cabinet is operating properly by raising its sash to its marked working height, making sure the control panel is not in alarm (e.g. Airflow alarm) and all lights inside are working.
12. Ensure red biological waste bags are in a suitable container and placed nearby the BSC to minimize the potential for cross contamination.
13. Disinfect the work surface with 70% alcohol or other suitable disinfectant.
14. Place items into the cabinet so that they can be worked with efficiently without unnecessary disruption of the airflow, working with materials from the clean to the dirty side.
15. Wear appropriate PPE. At a minimum, this will include a buttoned laboratory coat and gloves.
16. Adjust the working height of the stool or stand so that the worker's face is above the front opening.
17. Delay manipulation of materials for approximately 1 minute after placing the hands/arms inside the cabinet.
18. Minimize the frequency of moving hands in and out of the cabinet.
19. Dispose of contaminated gloves and replace with a clean pair before handling surfaces and materials outside of the BSC.
20. Do not disturb the airflow by covering any of the grill or slots with materials.
21. Work at a moderate pace to prevent airflow disruption that occurs with rapid movements.
22. Wipe the bottom and sides of the cabinet surfaces and any remaining equipment with disinfectant when work is completed. Disinfect non-waste items before removing them from the BSC.

Dispose of trash in a red biological waste bag, tie the bag closed and place in a designated biohazard cardboard box.