

UC Merced

Laboratory Safety Plan

Approved By: _____ Title: _____

Signature: _____

Date: _____

Revised 1/2014

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Introduction

The Laboratory Safety Plan (LSP) is intended to prevent injuries by helping laboratory personnel recognize, evaluate and control hazards in their laboratory. This is UC Merced's chemical hygiene plan and injury illness prevention plan for laboratories, and applies to all laboratories that use, store or handle potentially hazardous chemicals and all personnel who work in these facilities. Its effectiveness depends on the cooperation of faculty, staff, students, and the Office of Environmental Health and Safety (EH&S). It reflects Federal and State health and safety standards and published practices, standards, and guidelines of nationally recognized health and safety groups.

Rights

UC Merced faculty, staff, students, and visitors have a right to:

- A safe, healthful work environment.
- Information about potential hazards in the work areas.
- Training, in order to work safely in these environments.

Laboratory research and teaching must be done safely, as described in this plan. Moreover, this plan applies to UC Merced faculty, staff, hosted visitors, students, guests and volunteers, and contractors at locations where UC Merced has management control. This includes off site laboratories if the PI is compensated by UC.

UC Merced Laboratory Safety Plan

Each laboratory is required to have a health and safety plan that addresses chemical and physical hazards in the laboratory. This requirement is satisfied when all members of the laboratory have read and are familiar with all applicable sections of the Laboratory Safety Plan (LSP) and a completed Laboratory Safety Plan Supplement (LSPS). The LSP describes the proper use and handling practices and procedures to be followed by faculty, staff, students, visiting scholars, and all other personnel working with potentially hazardous chemicals in laboratory settings. The information presented in the LSP represents best practices and provides a broad overview of the information necessary for the safe operation of laboratories that utilize potentially hazardous chemicals. It is not intended to be all inclusive. Additional laboratory specific hazards and mitigation strategies should be listed in the LSPS. This plan is based on best practices identified in, among others sources, "Prudent Practices for Handling Hazardous Chemicals in Laboratories," published by the National Research Council, and the American Chemical Society's "Safety in Academic Chemistry Laboratories" (www.acs.org). All laboratory members should sign a LSP Training Sheet (Form 4 in the LSPS) and keep a copy in the lab's safety binder. The PI or an assigned laboratory member should update the LSPS annually and whenever laboratory operations change. All laboratory personnel should review the LSPS whenever there are changes. All laboratory spaces should be self-audited for compliance with the LSP at least once per year using the Self-Assessment Form (Form 3 of the LSPS). Once complete, the Self-Assessment Form should be placed in the lab's safety binder.

Implementation of the necessary work practices, procedures, and policies outlined in this CHP is required by the following:

- *Title 8, California Code of Regulations (CCR), Section 5191, "Occupational Exposures to Hazardous Chemicals in Laboratories"* (<http://www.dir.ca.gov/title8/5191.html>)
- *Title 8, CCR, Section 5209, "Carcinogens"* (<http://www.dir.ca.gov/title8/5209.html>)
- *Title 8, CCR, Section 5154.1, "Ventilation Requirements for Laboratory-Type Hood Operations"* (http://www.dir.ca.gov/title8/5154_1.html)

Other applicable regulations include those promulgated by the U.S. Department of Labor including 29 CFR 1910.1450 "Occupational Exposure to Hazardous Chemicals in Laboratories" (the "Laboratory Standard"). These regulations require that the CHP be readily available wherever potentially hazardous chemicals are used, handled or stored. EH&S will review and evaluate the effectiveness of this Plan at least annually and update it as necessary. The most current version of the plan can be found at <http://ehs.ucmerced.edu/research-safety>

UC Merced acknowledges the assistance of the UCLA Office of Environmental Health and Safety, whose Chemical Hygiene Plan has served as a useful resource. All responsibility for the content and use of the LSP, including any errors or omissions, rests, however, solely with UC Merced.

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Instructions for Completing the UC Merced Laboratory Safety Plan

There are two components to a complete Laboratory Safety Plan: this document, referred to as the Laboratory Safety Plan, and the Laboratory Safety Plan Supplement (LSPS), found at <http://ehs.ucmerced.edu/research-safety>. The LSPS is designed to contain laboratory-specific information and must be completed by each PI or an assigned laboratory member. Once complete, each member of the laboratory should read the LSP and LSPS and sign a copy of the LSP Training Sheet (Form 3 in the LSPS). Copies of all documentation (LSPS, Training Sheets) should be kept in the lab's safety binder. EH&S will review these documents during laboratory audits.

Purpose:

The LSP provides health and safety information to laboratory personnel that is tailored to their operations. If laboratory members read this LSP, complete the LSPS and implement its provisions, the laboratory will have satisfied all requirements for basic laboratory safety, including the Injury and Illness Prevention Program (IIPP) and Cal-OSHA Chemical Hygiene Plan.

The LSP covers general safety, chemical safety, and biosafety (BSL-1) issues. Additional authorizations are still necessary for work with biological hazards (BSL-2 and higher), lasers, radiation, controlled substances, select agents, and research using animals and human subjects.

Procedures for completing a laboratory-specific LSP:

Read this LSP.

Complete an LSPS (one for each PI).

Once the LSPS is completed, each laboratory member must review the generic LSP, LSPS and sign the LSP Training Sheet.

Copies of completed LSPS and training sheets should be kept in the lab's safety binder.

All laboratories should also conduct semi-annual self-assessments, using the LSP self-assessment form. Copies of completed self-assessments should also be kept in the lab's safety binder.

Procedures for updates and changes:

Laboratories are required to update their LSPS annually, or more frequently if operations change significantly. In addition, each laboratory member must review the LSP and associated LSPS and complete a new training sheet annually. Finally, each PI should notify EHS if his or her laboratory moves or if his or her contact information changes.

Laboratory Safety Roles and Responsibilities

Employees and other personnel who work in laboratories have the right to be informed about the potential health hazards of the chemicals in their work areas and to be properly trained to work safely with these substances. This includes custodial staff and other personnel who work to clean and maintain laboratories. Employees have the right to file a complaint with Cal/OSHA if they feel they are being exposed to unsafe or unhealthy work conditions and cannot be discharged, suspended, or otherwise disciplined by their employer for filing a complaint or exercising these rights. *All personnel working with potentially hazardous chemicals are encouraged to report (anonymously, if preferred) any concerns about unsafe work conditions to your health and safety officer.*

Responsibilities for the health and safety of the campus community extend to the highest administrative levels of UC. The Chancellor and Vice Chancellors are responsible for the implementation of UC's Environmental Health and Safety Policy (<http://ehs.ucmerced.edu/sites/ehs/files/public/EHS%20Policy%20with%20attachments.pdf>) at all facilities and properties under campus control. Deans and Department Heads are responsible for establishing and maintaining programs in their areas and for providing a safe and healthy work environment.

While the Chancellor, Vice Chancellors, Deans and Department Heads are responsible for the broad implementation and enforcement of UC's Environmental Health and Safety Policy, the day-to-day responsibility for the management of laboratory safety and adherence to safe laboratory practices rests with the PI/Laboratory Supervisor within individual laboratory units and associated departments. All personnel, including PIs/Laboratory Supervisors, employees, and students, have a duty to fulfill their obligations with respect to maintaining a safe work environment.

All employees and other personnel working with potentially hazardous chemicals have the responsibility to conscientiously participate in training seminars on general laboratory safety and review and be familiar with the contents of the LSP. Those working with chemicals are responsible for staying informed about the chemicals in their work areas, safe work practices and proper personal protective equipment (PPE) required for the safe performance of their job. Failure to comply with these requirements will result in progressive disciplinary action in accordance with UC policy, and may result in temporary suspension of laboratory activities until corrective action is implemented.

Specific duties and responsibilities of personnel who work in areas where potentially hazardous chemicals are present have been compiled in the document entitled General Rules for Laboratory Work with Chemicals, found in Appendix A.

RESPONSIBILITIES OF PRINCIPAL INVESTIGATOR (PI)/ LABORATORY SUPERVISOR

The PI/Laboratory Supervisor has responsibility for the health and safety of all personnel working in his or her laboratory who handle hazardous chemicals. The PI/Laboratory Supervisor may delegate safety duties, but remains responsible for ensuring that delegated safety duties are adequately performed. The PI/Laboratory Supervisor is responsible for:

1. Knowing all applicable health and safety rules and regulations, training and reporting requirements and standard operating procedures associated with chemical safety for regulated substances;
2. Identifying hazardous conditions or operations in the laboratory or other facility containing hazardous chemicals and determining safe procedures and controls, and implementing and enforcing standard safety procedures;
3. Establishing standard safety operating procedures (general and protocol specific) and performing literature searches relevant to health and safety for laboratory-specific work;
4. Providing prior-approval for the use of hazardous chemicals in the PI/Laboratory Supervisor's laboratory or other facility with hazardous chemicals;
5. Consulting with EH&S and/or Departmental Safety Committee on use of higher risk materials, such as use of particularly hazardous substances, as defined by UC Policy, or conducting higher risk experimental procedures so that special safety precautions may be taken;
6. Maintaining an updated chemical inventory for the laboratory or facility;

7. Ensuring laboratory or other personnel under his/her supervision have access to and are familiar with the appropriate Safety Manual(s);
8. Training all laboratory or other personnel he/she supervises to work safely with hazardous materials including applicable SOPs, and maintain written records of laboratory-specific or other specialized training in the appropriate Safety Manual(s) before students begin work. The lab safety fundamentals course must be completed before anyone begins working in the lab. Electronic records of training are encouraged. Training must include information of the location and availability of hazard information;
9. Promptly notifying EH&S and/or Facilities Management should he/she become aware that work place engineering controls (e.g., fume hoods) and safety equipment (e.g., emergency showers/eyewashes, fire extinguishers, etc.) become non-operational;
10. Ensuring the availability of all appropriate personal protective equipment (PPE) (e.g., laboratory coats, gloves, eye protection, etc.), the PPE is maintained in working order, and Lab Hazard Assessment (LHAT) has been completed for the lab;
11. Conducting periodic self-inspections of laboratory or facility and maintaining records of inspections, as required;
12. Promptly reporting of accidents and injuries to EH&S. Serious injuries MUST be reported to EH&S immediately to allow for compliance with the CAL/OSHA **8-hour** reporting time frame. Any doubt as to whether an injury is serious should favor reporting;
13. Provide funding for medical surveillance and/or medical consultation and examination for laboratory and other personnel, as required;
14. Informing facilities personnel, other non-laboratory personnel and any outside contractors of potential laboratory-related hazards when they are required to work in the laboratory environment; and
15. Identifying and minimizing potential hazards to provide a safe environment for repairs and renovations.

RESPONSIBILITIES OF ALL PERSONNEL WHO HANDLE POTENTIALLY HAZARDOUS CHEMICALS

All personnel in research or teaching laboratories that use, handle or store potentially hazardous chemicals are responsible for:

1. Reviewing and following requirements of the LSP and all appropriate Safety Manuals and Policies;
2. Following all verbal and written laboratory safety rules, regulations, and standard operating procedures required for the tasks assigned;
3. Developing good personal chemical hygiene habits, including but not limited to, keeping the work areas safe and uncluttered;
4. Planning, reviewing and understanding the hazards of materials and processes in their laboratory research or other work procedures prior to conducting work;
5. Utilizing appropriate measures to control identified hazards, including consistent and proper use of engineering controls, personal protective equipment, and administrative controls;
6. Understanding the capabilities and limitations of PPE issued to them;
7. Gaining prior approval from the PI/Laboratory Supervisor for the use of restricted chemicals and other materials;

8. Consulting with PI/Laboratory Supervisor before using these particularly hazardous substances (PHS), explosives and other highly hazardous materials or conducting certain higher risk experimental procedures;
9. Immediately reporting all accidents and unsafe conditions to the PI/Laboratory Supervisor;
10. Completing all required health, safety and environmental training and providing written documentation to their supervisor;
11. Participating in the medical surveillance program, when required;
12. Informing the PI/Laboratory Supervisor of any work modifications ordered by a physician as a result of medical surveillance, occupational injury or exposure; and
13. When working autonomously or performing independent research or work:
 - a. Reviewing the plan or scope of work for their proposed research with the PI/Laboratory Supervisor
 - b. Notifying in writing and consulting with the PI/Laboratory Supervisor, in advance, if they intend to significantly deviate from previously reviewed procedures (Note: Significant change may include, but is not limited to, change in the objectives, change in PI, change in the duration, quantity, frequency, temperature or location, increase or change in PPE, and reduction or elimination of engineering controls.)
 - c. Preparing SOPs and performing literature searches relevant to safety and health that are appropriate for their work; and
 - d. Providing appropriate oversight, training and safety information to laboratory or other personnel they supervise or direct.

RESPONSIBILITIES OF EH&S AND CHEMICAL HYGIENE OFFICER (CHO)

EH&S is responsible for administering and overseeing institutional implementation of the Laboratory Safety Program. The Chemical Hygiene Officer (CHO) has primary responsibility for ensuring the implementation of all components of the LSP. In case of life safety matters or imminent danger to life or health, the Director of EH&S or designee has the authority to order the cessation of the activity until the hazardous condition is abated. EH&S provides technical guidance to personnel at all levels of responsibility on matters pertaining to laboratory use of hazardous materials. The CHO is a member of EH&S and, with support from other EH&S personnel, is responsible for:

1. Informing PIs/Laboratory Supervisors of all health and safety requirements and assisting with the selection of appropriate safety controls, including laboratory and other workplace practices, personal protective equipment, engineering controls, training, etc.;
2. Conducting periodic inspections and immediately taking steps to abate hazards that may pose a risk to life or safety upon discovery of such hazards;
3. Performing hazard assessments, upon request;
4. Maintaining area and personal exposure-monitoring records;
5. Helping to develop and implement appropriate chemical hygiene policies and practices;
6. Having working knowledge of current health and safety rules and regulations, training, reporting requirements and standard operating procedures associated with regulated substances. Such knowledge may be supplemented and developed through research and training materials;

7. Working with the Chemical Safety Committee to review existing and developing new SOPs for handling hazardous chemicals;
8. Providing technical guidance and investigation, as appropriate, for laboratory and other types of accidents and injuries;
9. Helping to determine medical surveillance requirements for potentially exposed personnel;
10. Reviewing plans for installation of engineering controls and new facility construction/renovation, as requested;
11. Reviewing and evaluating the effectiveness of the CHP at least annually and updating it as appropriate; and
12. Providing management oversight and assistance with environmental compliance, transport and disposal of hazardous waste.

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Section 1 – Responding to and Reporting Worker Injuries

This section provides information on responding to and reporting workplace injuries. All laboratory personnel should be familiar with the procedures and emergency contact information described below.

Medical Emergency

In the event of a medical emergency:

- Remain calm and begin lifesaving measures as necessary.
- Call for emergency response, dial **9-911 from a campus phone** or CAT-COPS (228-2677), or 911 from a cell phone.
- Keep injured person warm
- Do not remove injured person unless there is a danger of further harm.

Contact one or more of the following for further assistance:

Olivewood Occupational Health ----- (209)205-1001 374 Olive Ave, Merced

Mercy Hospital (Emergency Room)----- (209) 385-7000 333 Mercy Ave, Merced

Castle Medical Center (Urgent Care) ----- (209) 726-1235 3605 Hospital Road, Atwater

California Poison Center----- (800) 876-4766

Injured employees at the UC Merced Campus should go to Olivewood Occupational Health or the Mercy Medical Center emergency room and injured employees at the Castle Facility should go to the Castle Medical Center Urgent Care Center. After treatment, injured employees should report their injuries to the Human Resource Office (228-2946) and their supervisor. **Severe injuries / accidents must be reported to EH&S within 8 hours.** During non-business hours, report emergencies to CAT-COPS. Serious injuries / accidents include those that result in death, permanent impairment or disfigurement, or require hospitalization. Examples include amputations, lacerations with severe bleeding, severe burns, concussions, fractures and crush injuries.

Medical Surveillance

Medical surveillance is needed when working with infectious agents such as bloodborne pathogens and risk group 3 agents, regulated carcinogens, live animals, radiation or when using a respirator. Contact EH&S at 228-7864 to access the program.

First Aid Kit

All first aid kits used at UC Merced should have, at a minimum, the items listed below. Personnel should supplement their kits according to their own needs. Where special hazards are present (e.g. hydrofluoric acid, etc.) additional items may be necessary. Contact EH&S for further information at 228-7864.

First Aid Kit Required Contents

<u>Description</u>	<u>Quantity</u>
Fingertip bandage	10
Knuckle bandage	8
1" x 3" adhesive bandage	16
Adhesive tape, 2" x 5yds	1
Alcohol preps	10
2" x 10 yds sterile gauze	1
5" x 9" gauze compress	2
3" x 3" sterile gauze pads	4

The Laboratory First Aid kit is only intended for minor injuries; seek medical attention by dialing 9-911 for all medical emergencies. PIs are responsible for restocking the First Aid kits after each use and for annual inventory. Additional First Aid kits may be purchased from Grainger. The “Construction First Aid Kit” (Item #5M585) is appropriate for laboratory use.

All laboratory workers should also be familiar with the Emergency Procedures outlined in Section 2 and know the locations of emergency showers, fire extinguishers and other emergency equipment. Proper use of this equipment will save lives and minimize damage to personnel and property.

The first response for most chemical spills splashed on the skin or in the eyes is to rinse the affected area with fresh water **for at least 15 minutes** (the exposed person will need assistance with this) using an eyewash/ shower (2 minutes for HF exposure, and always call an ambulance). If an eyewash or shower is not immediately available, wash hoses on many laboratory sinks can be used as a temporary substitute. Seek medical attention if necessary. Call 9-911 and request an ambulance if needed.

Certain chemicals pose hazards that require a specific antidote in the laboratory. All laboratory personnel working with *hydrofluoric acid* should have *calcium gluconate gel* in case of exposure and should understand its use.

Laboratory personnel working with organophosphates or cyanide may also need specific antidotes. Contact EH&S for more information.

Section 2 – Emergency Preparedness

This section provides information to help individuals and laboratories prepare for a variety of emergencies. The Principal Investigator should review the material and fill in appropriate information in their LSPS.

Fires, earthquakes, and natural disasters are a constant reality. Three large earthquakes have struck the west coast of North America in the last several years – Mexico City (1985), Loma Prieta (1989), and Northridge (1994). The Loma Prieta earthquake was strong enough in Merced to slosh water out of swimming pools. All workers should prepare a “grab and go” bag with basic supplies (see the Individual Preparedness Checklist in this Section). In addition, each laboratory should take basic steps to prepare for a disaster to mitigate damage and to speed recovery after a disaster (see the Laboratory Preparedness Checklist in this Section).

Each laboratory should designate a primary and secondary emergency contact for after-hours emergencies in the LSPS. Home phone numbers are confidential and are only available to EH&S and emergency personnel.

Evacuation Procedures

All laboratory members need to know the location of the emergency gathering point for their laboratories. Additionally, each should maintain a current list of all laboratory personnel that is easily accessible, preferably near a door or exit, to keep track of personnel during an evacuation. Contact EH&S at 228-7864 for assistance with evacuation routes and other preparedness issues.

To minimize damage in an earthquake:

- Tall objects should be secured to a wall or other support.
- Shelves, especially chemical storage shelves, should have lips to keep containers from falling
- Heavy equipment should never be stored overhead.
- Computers and other equipment should be secured to prevent damage in an earthquake.
- Access and egress pathways leading from the laboratory to the hallway and from the hallway out of the building should not be blocked with stored equipment, boxes, or furniture.

Please refer to the attached LSPS for the List of Laboratory Personnel and the location of the Gathering Point in case of an evacuation. Please keep your list of laboratory personnel updated in the Lab Hazard Assessment Tool (LHAT), located at <http://ehs.ucop.edu/lhat>

Individual Emergency Preparedness

Major disasters could strand personnel at UC Merced for as long as three days. Prepare yourself and your family by gathering the supplies indicated below for yourself at work and for your family at home.

Individual Preparedness

Everyone should be prepared for emergencies wherever they are. You could be stuck in your car, unable to travel for many hours, or forced to leave your car and walk. Damage to bridges, roads and freeways could strand you at home or work for several days. Preparation will help keep you and those who depend on you safe and comfortable.

EH&S strongly recommends that each member of the University community carefully consider obtaining the following items:

In Your Car

Store in the car's trunk several days' supply of food bars, water, first aid kit, all required medications, flashlight, emergency space blanket, warm jacket, flares, good pair of walking shoes, and money.-

At Home

Develop a family earthquake plan, including out-of-state contacts. Store a sturdy pair of shoes, gloves and flashlight with fresh batteries under your bed. Store food, water and emergency supplies adequate for at least 72 hours. These supplies are available in commercial kits, discussed below. Sufficient cash should also be available.

Food

Select foods that your family enjoys and will meet special dietary restrictions or infant needs. Rotate food items and don't forget about pets!

Water

Each person in your family will need from one-half to one gallon of water per day. Water should be stored in sealed plastic containers and kept in cool, dark locations. Date each container and change the water every three months.

Medical Supplies

Individuals should have at least a basic first aid kit, plus supplies of any required medications.

Storage of Supplies

Small materials and supplies should be bagged in categories and stored inside of sealed plastic or metal trash containers, storage lockers, or a heavy wooden box. Containers should be stored in cool, dry locations.

Preparedness Kits

Departments are also strongly encouraged to consider the purchase of emergency supplies (pre-packaged food, water, and first aid supplies) for their personnel.

Laboratory Emergency Preparedness

Minimize impact of disasters on laboratory operations by taking simple steps to prepare. Planning and preparation can minimize damage and get the laboratory operating as soon as possible.

Laboratory Preparedness

Preparation for emergencies is essential within our research community at UC Merced; prepared laboratories will suffer less damage and be able to restore laboratory operations in a timely manner. Taking action before emergencies occur can save lives, time and money. **Be sure to include the following items in your emergency preparations:**

- Store all critical research documentation outside the laboratory to avoid the total loss of research data in the event of fire, etc.
- Obtain information regarding back-up resources (i.e. freezers, refrigerators, incubators, etc.) to preserve critical cell lines, organisms, etc.
- Secure all large pieces of equipment to the walls and remove any large heavy objects from shelving units for protection in an earthquake.
- Mount power strips to a wall and keep a roll of plastic sheeting on hand in case of flooding.
- Assign a “buddy” to help evacuate any disabled persons working in the laboratory.
- Emergency phone numbers including police, fire, poison control, medical care and EH&S can be found in this Plan and should also be posted in a prominent location within the laboratory.

Items that everyone in the laboratory should have:

- Names, phone numbers (home and cell), and travel time to campus of key laboratory personnel.
- Location and inventory of all laboratory emergency supplies (first aid kits, etc.), including a laboratory spill kit (see Section 11), which are available from EH&S, along with combinations to locks and/or location of keys for access.
- Location of nearest fire extinguishers, alarm pull boxes, showers, etc.
- Evacuation map of all possible exits out of the structure. Include the location of designated gathering points away from the building.

Laboratory emergency preparedness is critically dependent on every individual within the laboratory. Only through careful and thoughtful preparation can a laboratory diminish the hazards.

Section 3 – Fire Safety

It is better to prevent fires than to fight fires. Review the materials on Electrical Safety (Section 4), Chemical Safety (Section 7), Chemical Storage (Section 8) and other applicable topics to reduce the potential for fires.

In case a fire occurs, all laboratory personnel should know how to report fires, the location and proper use of fire extinguishers in their work areas, and how to evacuate the building.

To report a fire - call 9-911, then quickly evacuate the area (see Evacuation Procedures, Section 2), closing the laboratory door as you leave.

Personnel should only use an extinguisher for small (trash-can or lab bench size) fires and only if there is an escape route behind you. It is important to be aware of the locations and types of fire extinguishers in the laboratory. Fire extinguishers will be charged annually by a contractor and inspected monthly by Facilities Management to verify that they are charged, that the seal is intact and that they are accessible.

Please refer to the attached LSPS for the location of fire extinguishers in your laboratory.

Pyrophoric chemicals, air and water reactive chemicals, and chemicals that give off toxic by-products or that rapidly polymerize when burned require special fire-fighting procedures. Please indicate the presence of any of these materials in Section 3 of your laboratory-specific LSPS. These require specific standard operating procedures (SOPs).

Used or partially charged extinguishers must be immediately reported to Facilities Management Help Desk at 228-2986.

Fire Extinguisher Selection

Take the time to learn about the extinguishers in your area. Having the right extinguisher, knowing its location and how to use it can save lives and property.

Fire Extinguisher Selection

The National Safety Council estimates that most fires occurring in the United States are easily contained with a single fire extinguisher at the time the fire is first discovered. UC Merced utilizes three basic types of extinguishers: water, carbon dioxide, and dry chemical, depending on the material burning. You cannot use all types of extinguishers safely on all types of fires!



Class A Fire - involves ordinary combustible materials (trash, wood or paper).



Class B Fire - involves burning liquids (gas, paint, etc.)



Class C Fire - involves energized electrical equipment

Each extinguisher contains a ~~neuter~~ rating (A, BC or ABC) on its label, which guides the user to the proper class of fire for that specific extinguisher. Water extinguishers are only to be used on "Class A" fires; CO₂ extinguishers can be used on "B" and "C" fires; and dry chemical types ("Class ABC") can be used on all classes of fire (except for combustible metals). If there are combustible metals in the laboratory, contact EH&S at 228-7864 to see if you need a special Class D extinguisher. A bucket of sand can be used in lieu of a Class D extinguisher. The fire-fighting agent in ABC extinguishers is a very fine mixture of ammonium phosphate and anti-caking agents. If an ABC extinguisher is discharged, carefully sweep or vacuum the residue and wipe all flat surfaces thoroughly. This material has a very low toxicity; however, the dust can be irritating so ensure that there is plenty of fresh air during cleanup.

Review the extinguishers in your area to make sure they are appropriate for the materials used. In addition, visually inspect each extinguisher every month to make sure it is still in place and that the indicator arrow on ABC extinguishers is in the green area. Every extinguisher will be recharged annually by Facilities.

Call Facilities Management help desk at (209) 228-2986 to report fire extinguisher problems.

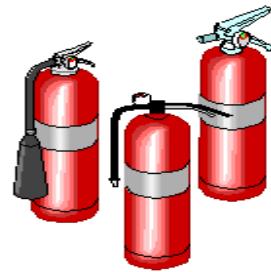
Using a Fire Extinguisher Safely – PASS

Learn about extinguisher operation before you need the extinguisher. They are very simple to use, but practice can prevent a disaster.

Pull-Aim-Squeeze-Sweep...PASS

Extinguisher Operation

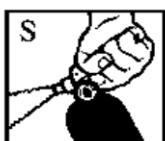
Although extinguishers vary in size, color, and type of extinguishing agent, the vast majority of devices operate basically the same way. Stand six to eight feet from the fire with your back to an unblocked exit. If the fire is small, heavy smoke is NOT present and you have an exit available to you for evacuation purposes, grab the nearest appropriate extinguisher and operate the following P-A-S-S procedure:



P - Pull the pin located in the extinguisher's handle.
(Twist to break the seal.)



A - Aim the nozzle, horn or hose at the base of the fire.



S - Squeeze or press the handle.



S - Sweep from side to side at the base of the fire until it is out.

Used or partially charged extinguishers must be immediately reported to Facilities Management Help Desk at (209) 228-2986.

Section 4 - Electrical Safety

This section provides information about electrical safety in research laboratories. Laboratory-specific information is described in the LSPS, which should be completed by the PI.

Electrical hazards cause many fires on university campuses each year. They are also one of the leading causes of workplace fatalities in the United States. To protect against electrical hazards and to respond to electrical emergencies, it is important to identify the electrical panels that serve each laboratory space. Access to these panels must be unobstructed, with a clearance of 36," and they must be clearly labeled. Each room will be serviced by one or more electrical panels. These will be identified by panel- and circuit-labels near the outlet in each laboratory. The location of the electrical panel(s) that serves your laboratory is described in the attached LSPS. In addition, it is important that laboratories prevent fire and shock hazards by observing the following precautions:

- **Do not use extension cords for permanent wiring (extension cords should not supply power to permanent equipment like refrigerators) and do not run extension cords through walls.**
- **Electrical cords on equipment must be in good condition, not frayed or cracked. Damaged cords must be removed or repaired, not taped over.**
- **Multi-outlet power strips must have overload protection (circuit breakers) and must not be connected to other power strips or extension cords.**
- **Electrical cords and extension cords must plug directly into the wall without adapters. An electrician should do all repairs and modifications.**
- **Ground Fault Circuit Interrupters (GFCI) must be used in wet areas around sinks, tanks, etc.**
- **Power strips should be located off the floor in case of flooding.**

Section 5 – Laboratory Ergonomics

This section provides information about ergonomics in laboratories. Laboratory-specific information is described in the attached completed LSPS.

The purpose of an ergonomics program is to reduce or eliminate hazards that contribute to the development of Cumulative Trauma Disorders (CTDs), a class of disorders related to repetitive motions. Ergonomic injuries are the fastest growing category of workplace-related injuries.

Applying ergonomic principles can help reduce the risk of injuries for those who work with computers, laboratory equipment, and in any other jobs that require repetitive activities or heavy materials handling. Pipetting, microscope work, computer use, and improper lifting techniques are common causes of ergonomic injuries in laboratories and can be avoided by following the guidelines described in the following pages.

Risk factors for CTDs include: repetitive tasks, awkward postures, vibration, forceful exertions and heavy lifting. Allow your body to recover after these activities:

- **Take frequent breaks**
- **Move around**
- **Don't repeat the same motions for hours on end**
- **Avoid awkward motions and postures**
- **Perform relief exercises**
- **Expand the tasks each person performs to minimize the constant repetition of any one particular task**

Awkward postures, repetitions, and use of force are not always harmful. They are likely to cause injury, however, when sustained over time when your body doesn't have a chance to recover. The result can lead to overexertion, injury and perhaps permanent damage.

One of the key aspects of the ergonomics program is identifying and educating employees who have a high risk of developing cumulative trauma disorders. Early identification of symptoms with prompt intervention helps prevent serious or chronic problems.

To schedule an ergonomic evaluation or for further information please contact EH&S at 228-2347.

Ergonomics in Research Laboratories

Pipetting and microscopy present a variety of ergonomic hazards. Apply the general guidelines below to minimize the risk associated with these activities. Contact EH&S for more information.

The Pressures of Pipetting

Pipetting involves several ergonomic stresses that can be exacerbated by the mental pressure resulting from the accuracy, precision and timing demanded in the procedures. If you spend more than one hour per day pipetting:

- Rotate pipetting tasks among several people.
- Take short pauses of a few seconds, when you can't take a longer break.
- Choose pipettors requiring the least pressure and use only the force necessary to operate the pipettor.
- Work with arms close to the body to reduce strain on shoulders. Don't elevate your arm without support for lengthy periods. Keep head and shoulders in a neutral position (bent forward no more than 30 degrees).
- Use adjustable chairs or stools with built-in solid footstools. Don't use a foot ring, which could compress blood vessels in feet, and don't use a high stool that can force you to work with a bent neck.
- Use shorter pipettes and low profile waste receptacles for used tips. This decreases hand elevation and consequent awkward postures.

Microscopes

If you spend more than one hour per day using a microscope:

- Spread your use over the entire day if you will use it for more than five hours in a day.
- Keep microscope clean and use illuminators and shadow boxes properly to avoid visual and musculoskeletal strain.
- Adjust chair height so thighs are horizontal and feet are flat on the floor.
- Make sure the backrest provides proper lumbar support and be sure to readjust when you change positions.
- Select chairs with padded armrests to avoid compressing the ulnar nerve in your arm.
- Position work surfaces high enough to allow close inspection without inclining your head beyond 17-29 degrees.
- Use a cutout worktable. This puts you close to the microscope and provides area for supporting forearms.

Healthy Computer Use

Workers are spending an increasing amount of time sitting at computers. Follow the guidelines below to minimize the impact of this activity.

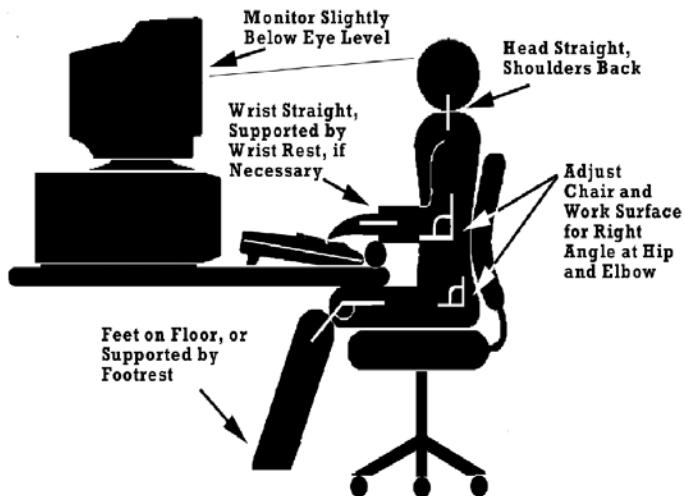
Computer Self-help Checklist

It is the responsibility of each computer operator to recognize the risks associated with computer use and to take proactive, corrective measures to reduce potential injuries.

The following is a "quick reference" checklist that identifies some ergonomic issues associated with computer use.

Follow the guidelines below to achieve a neutral, relaxed posture:

- Sit directly in front of monitor and keyboard.
- Make sure the top of the screen is at eye level.
- Check for glare. To minimize glare, close blinds, reposition monitor to be perpendicular to the window, or install an anti-glare or privacy screen.
- Maintain an approximately 90-degree angle in elbows.
- Keep wrists straight and aligned with forearm.
- Sit "snugly" in chair to keep lower back well supported.
- Keep arms close to body when typing or using mouse.
- Move entire hand/wrist area when operating a mouse.
- Bring frequently used items close to work area to avoid overreaching and repetitive stretching.
- Place feet firmly on the floor or footrest.
- Move yourself around the work area using your feet, rather than pulling with your hands.
- Allow adequate legroom under workstation for stretching and periodic position changes.



To schedule an ergonomic evaluation or for more information, please contact EH&S at 228-ERGO.

Lifting and Materials Handling Guidelines

Proper Lifting Techniques Can Help Prevent Injuries

The human back is a column of 33 vertebrae separated by small, round discs filled with a thick fluid, all held together by ligaments and muscles. If the ligaments and muscles are weak, the vertebrae and discs can become misaligned. Excessive lifting, a sudden fall, or other traumatic action can injure the back, or, over a period of years, the discs may simply "wear out". You can also "strain" or "sprain" the muscles and ligaments in your back.

Poor physical condition, excessive body weight, poor posture, and poor lifting technique contribute to the number and severity of back injuries. Degeneration of the spine due to aging is a major contributor to lower back pain, but is frequently misdiagnosed as a sprain or strain.

Before you lift anything, think about the load you'll be lifting. Ask yourself, can I lift it alone? Do I need mechanical help? Is it too awkward for one person to handle, or should I ask a coworker for help?

If the load is manageable, there are seven rules for safe lifting to help minimize injuries to the back:

- **Lift Comfortably.** Choose the position that feels best, with a straight back.
- **Avoid Unnecessary Bending.** Do not place objects on the floor if they must be picked up again later.
- **Avoid Unnecessary Twisting.** Turn your feet, not your hips or shoulders. Leave enough room to shift your feet so as not to have to twist.
- **Avoid Reaching Out.** Handle heavy objects close to the body. Avoid a long reach to pick up an object.
- **Avoid Excessive Weight.** If the load is too heavy, get help or use a mechanical device, if possible.
- **Lift Gradually.** Lift slowly, smoothly and without jerking.
- **Keep in Good Physical Shape.** Get proper exercise and maintain a good diet.

Be sure to use the same safe techniques when you set the load down. It takes the same time to lift safely lift than to do an unsafe lift, so why not play it safe and lift it right?

Section 6 – Laboratory Relocation

This section describes requirements for laboratory moves, relocations, and equipment clearances. Supplementary information is included on the following pages.

Laboratory moves and relocations create the potential for a variety of problems, including accidents, injuries and chemical, biological and/or radiation spills. Before any relocations or closures of laboratory space, review these requirements and notify EH&S.

The Principal Investigator vacating laboratory space is responsible for removing **ALL** hazards from that laboratory space. Laboratory areas cannot be re-occupied and work cannot be performed by contractors until a green Clearance Card is posted by EH&S. Notify EH&S in advance of the move and use the UC Merced Laboratory Clearance Checklist (next page) to keep track of all the details.

Before You Move:

- Careful planning minimizes the time and expense of the move.
- Notify EH&S to begin clearance process.
- Dispose of as much hazardous waste as possible; see Sections 12 and 24 for more information.
- Pack hazardous materials securely, according to the guidelines in Section 18. Do not ship materials off-site without contacting EHS.
- All equipment must be decontaminated prior to the move. Some equipment may be cleaned by laboratory personnel, other equipment such as biological safety cabinets, must be decontaminated by an appropriate contractor. Refer to the Laboratory Safety Plan, Biosafety Manual or Radiation Safety Manual for complete information. These can be found on the EH&S website under Research Safety.

When you move:

- Sort materials according to compatibility, store in appropriate containers and keep a packing list for each box. Proper packaging will prevent spills of hazardous materials. If a spill or release does occur, call EH&S at (209) 228-2EHS or 9-911 immediately.
- Use proper lifting techniques when moving. If injuries occur, seek treatment and report them promptly to the Human Resources Office at 228-2949. See Section 5 for information on lifting techniques.
- Do not move chemicals or hazardous materials, including compressed gases or radioactive materials (RAM), outside of buildings and never use personal vehicles to transport hazardous materials. EH&S or a hazardous materials vendor will move all hazardous materials.

REMEMBER – An important part of the clearance process is removing items, such as razor blades, needles and even dust on shelves that could be perceived as hazardous by workers unfamiliar with research laboratories, such as movers, contractors and other personnel. Investigators vacating or relocating within UC Merced facilities are responsible for leaving laboratories in a state suitable for reoccupation or renovation. EH&S must be notified of all moves in laboratory spaces. Upon notification, EH&S will post a red “Not Clear of Hazards” tag. Once the items below have been completed the red tag will be replaced with a green “Clearance” tag. Space cannot be reoccupied and no work can be done in a space until the green “Clearance” tag is posted.

UC Merced Laboratory Clearance Checklist

General Housekeeping

- Notify EH&S of move and ensure new space is cleared for occupancy.
- Broken glassware and clean sharps removed in puncture-resistant containers.
- Laboratory equipment and supplies decontaminated before removal from laboratory.

Biohazardous Materials

- Work surfaces cleaned/ disinfected.
- All potentially biohazardous waste disinfected and removed from laboratory, including sharps containers.
- All media and supplies removed from drawers, shelves, and cabinets.
- Biosafety cabinets decontaminated prior to moving and recertified after the move. Contact EH&S at (209) 228-2347 for details.

Radioactive Materials

- Survey facilities and equipment by meter and wipe test for contamination. Forward a copy of the wipe test, LSC printout, and corresponding map to EH&S.
- Surfaces and equipment cleaned, with radiation levels less than or equal to twice instrument background. If non-removable contamination is detected, contact EH&S.
- Radioactive waste appropriately packaged and removed.
- EH&S contacted for final clearance and survey.

Chemical Safety

- All laboratory chemicals, including wastes, must be removed from the laboratory.
- All empty bottles and cans removed. Containers should be defaced and the caps removed.
- Benchcoat and disposable liners/covers removed from work surfaces.
- Laboratory bench tops washed with soap and water.
- Debris removed from fume hoods and fume hood surfaces wiped down.
- Water run into all sinks and floor drains to fill traps. It is recommended that several tablespoons of mineral oil be poured in each drain to inhibit evaporation from the trap.
- EH&S notified if perchloric acid has been used in fume hoods.
- Once the lab has been decontaminated, remove any hazardous material signage (i.e., carcinogens, biohazards).

Contractor Safety Sheet

Procedures When Contractors Work in Your Laboratory

Laboratory personnel should understand the work the contractors are doing, especially any actions that could affect laboratory operations. Contractors should not move laboratory equipment or chemicals without assistance and approval from laboratory workers.

If contractors are working in the laboratory, help them understand that:

- Biohazard signs indicate the use of biological organisms. These are generally well-contained and researchers are trained to decontaminate work areas after use.
- Radiation is used in many laboratories, usually in very small amounts. All laboratories are checked regularly by EH&S and by laboratory staff to make sure they are not contaminated.
- Chemicals are found in most laboratories. These are used mostly in fume hoods, and are stored throughout the laboratory. Laboratory staff should remove all chemicals from the work area.

Laboratory personnel should be available to answer any questions from the contractor.

Entering a Laboratory – Contractors should not enter any area or laboratory with a sign that warns against unauthorized entry or that says “keep out,” unless specifically directed to do so.

Working In Fume Hoods - If the project involves significant work inside a fume hood, laboratory staff must remove chemicals, equipment, and supplies and wipe the inside surface of the hood prior to the work being performed; EH&S personnel must clear the hood and post the green “Clearance Tag.”

Working in an Unoccupied Space - When laboratory personnel leave an area, EH&S will post a red tag and laboratory staff must remove materials, decontaminate surfaces and wipe down work areas. After hazards are removed, EH&S will post a green “Clearance Card.” Contractors should contact laboratory personnel, EH&S or Facilities Management with questions about potential hazards.

How should contractors protect themselves from hazards in laboratories?

- Do not eat or drink in a laboratory and wash hands after leaving laboratory.
- Wear gloves, such as single use, surgical-type nitrile gloves.
- Wear eye protection and protective clothing such as a laboratory coat or coveralls.

When working with equipment that might generate heat or sparks, it is extremely important that flammable materials are removed from the work area before they begin work. All gas cylinders should be removed before work begins.

What should contractors do if an emergency occurs?

- **Fire** - use a fire extinguisher if trained and the fire is small enough. For all other fires, evacuate the area, close the door, pull the fire alarm and call 9-911 from a campus phone.
- **Spill** - If any chemical, biological, or radioactive materials are spilled, notify others in the area, close the door and call EH&S for assistance at (209) 228-2EHS.
- **Injury** – If a significant injury occurs, call 9-911. For minor injuries contact your supervisor and Human Resources.

Clearance Tag

A green “Clearance Tag” indicates the removal of identified hazards from a space. The tag must be posted at the end of laboratory relocations before custodial services or other service individuals can enter the premises.

Remember –

Personnel vacating laboratory space are responsible for removing all hazards from that space. Once EH&S has been notified of intent to vacate a laboratory space, a “Red Tag” will be posted by EH&S indicating that the clearance process has begun. Use the Relocation Checklist to assist you in this process.

When all hazardous materials have been removed, a green “CLEARANCE TAG” will be posted by EH&S staff indicating that the space is ready for the next occupant.

Laboratories that do not meet the relocation guidelines will not have a green “CLEARANCE TAG” posted.

If you have any questions regarding this process, call EH&S at (209) 228-2EHS for assistance.

ENVIRONMENTAL, HEALTH & SAFETY

CLEARANCE

This room (item) has been surveyed to ensure that hazardous items or conditions have been removed. This posting indicates that the area (item) has been CLEARED so that clearing, construction and/or repair work may proceed. Labs may not use item/ area until work is complete.

Date: _____

Location (BLDG, ROOM): _____

Item(s): _____

EH&S Contact Person: _____

Phone Number: _____

Section 7 –Chemical Safety

This section begins the chemical safety section of the LSP. The Principal Investigators should review this material and develop a set of safety practices suitable for their laboratories. It is especially important that each laboratory develops procedures or Standard Operating Procedures (SOPs) in the LSPPS. Laboratory personnel should review this LSP, the laboratory-specific LSPPS, and sign their copies of the LSP Training Sheet.

7.1 Guidelines for Written Safety Procedures

At a minimum, all chemicals should be handled according to UC Merced’s Basic Chemical Handling Procedures. Beyond this, each laboratory should use the information from SDSs and other appropriate resources to gather health and safety information and develop procedures to handle chemicals safely. Once this information is gathered, appropriate laboratory procedures or SOPs must be written into the LSPPS. SOPs can be written in Radical at <http://ehs.ucop.edu/radical>

Safety issues to be addressed in the SOPs include:

- A description of the procedure and chemicals involved*
- Engineering controls used – Section 9*
- Personal Protective Equipment (PPE) necessary – Section 10*
- Spill and emergency procedures – Section 11*
- Waste disposal procedures – Section 12*
- Any approvals necessary, specific decontamination procedures or designated areas for specific operations*

Items above may be included in the LSPPS by reference to the appropriate section of this Laboratory Safety Plan. A template is available in Appendix D, or at <http://ehs.ucmerced.edu/node/75>

Safety procedures are most effective when included in written laboratory procedures or SOPs. In some cases, laboratories prefer to have them available as separate safety SOPs. In either case, they must be available in the LSPPS and all personnel should know the procedures for their laboratory.

Written procedures for work with carcinogens and acutely hazardous substances should include sufficient detail to ensure the safety of all laboratory personnel. In particular, procedures should include:

- Storage and security requirements (if any)
- Procedures to prevent contamination (e.g. leaving gloves and other PPE in work area)
- Any specific decontamination procedures
- Notification and evacuation procedures in the event of a spill

7.2 Hazard Communication

UC has an established Hazard Communication Program that complies with 8 CCR 5194 (<http://www.dir.ca.gov/title8/5194.html>), the Cal/OSHA Hazard Communication Standard.

The purpose of UC's Hazard Communication Program is to ensure that all employees and, upon request, their personal physicians, have the right to receive information regarding the hazardous substances to which they may have been exposed at work. UC is responsible for providing information about the hazardous substances in our workplace, the associated hazards, and the control of these hazards, through a comprehensive hazard communication program that is summarized briefly below. The requirements of the Hazard Communication Program apply to laboratory environments at UC due to the potential for large scale experiments and for activities that may occur outside of areas where engineering controls are available. Proper hazard communication involves the active participation of the PI/Laboratory Supervisor, the EH&S Chemical Safety Officer, and the Laboratory/Facility Safety Coordinator, who are each responsible for providing consultation and safety information to employees working with hazardous chemicals.

List of Hazardous Substances

All labs are required to keep an updated copy of their chemical inventory at <http://ehs.ucmerced.edu/research-safety/chem-inventory>. For each hazardous substance on their inventory, specific information on any associated health or safety hazards must be made readily available to all laboratory personnel. Compressed gases need to be included in the inventory list.

Hazard Determination

PIs/Laboratory Supervisors are responsible for verifying if any items on their chemical inventory are subject to the requirements of the hazard communication regulation.

The term “hazardous substance” refers to any chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed individuals. Hazardous substances include, but are not limited to, those chemicals listed in the following:

1. “The Hazardous Substance List”, commonly known as the Directors List of Hazardous Substances, 8 CCR 339 (<http://www.dir.ca.gov/title8/339.html>);
2. “Toxic and Hazardous Substances, Air Contaminants”, 8 CCR, Section 5155 (<http://www.dir.ca.gov/title8/5155.html>);
3. “Threshold Limit Values for Chemical Substances in the Work Environment”, ACGIH, 2004;
4. “Sixth Annual Report on Carcinogens”, NTP, 1991;
5. “Monographs”, IARC, WHO (<http://www.iarc.fr/en/publications/list/monographs>);
6. SDSs for reproductive toxins and cancer causing substances (<http://map.ais.ucla.edu/go/1002824>); and
7. “Chemicals Known to the State to Cause Cancer or Reproductive Toxicity” (Proposition 65), 22 CCR 12000.

Inventory items found on the above lists are subject to the requirements outlined below

SAFETY DATA SHEETS (SDS)

An SDS must be available for each hazardous substance in a laboratory's chemical inventory. SDSs are available from the UC online SDS library, available on the UC website: <http://ehs.ucmerced.edu/material-safety-data-sheets>.

PIs/Laboratory Supervisors are responsible for keeping SDSs current and making them available to all laboratory employees throughout the work day. SDSs must be in a central location that can be accessed immediately in the event of an emergency. Electronic copies may be kept in a file on a group drive, or hard copies maintained in a central location in the laboratory.

New chemical substances synthesized or produced in a laboratory, and used or shared outside of a laboratory suite, require the preparation of an SDS for each synthesized substance. The UC-system wide SDS library has the capability of developing new SDSs based on the known chemical and physical properties of that substance. Contact your health and safety officer for more information on preparing new SDSs.

A sample SDS and information on its contents is available in *Appendix B*

LABELS AND OTHER FORMS OF WARNING

Labeling requirements for all hazardous substances are summarized as follows:

- All containers of hazardous materials must be labeled with the identity of the hazardous substance
- The label must contain all applicable hazard warning statements
- The name and address of the chemical manufacturer or other responsible party must be present
- Manufacturer's product labels must remain on all containers, and must not be defaced in any way. Appropriate hazard warning statements and Proposition 65 warnings must be present, if not that information must be added
- Labels must be legible, in English, and prominently displayed
- Symbols and/or other languages are required for non-English speaking employees
- Secondary containers (such as spray bottles) must be labeled with the identity of the substance and appropriate hazard warnings
- New synthesized compounds must be labeled with the appropriate hazard warnings based on the knowledge of the chemical and physical properties of that substance.

Additional information on container labeling is provided in *Appendix C*.

PERSONAL PROTECTIVE EQUIPMENT (PPE) AND LAB HAZARDASSESSMENT TOOL

See section 10.

 ScienceLab.com
Chemicals & Laboratory Equipment


Health 3
Fire 2
Reactivity 0
Personal Protection 0

Material Safety Data Sheet
Formaldehyde 37% solution MSDS

Section 1: Chemical Product and Company Identification	
Product Name: Formaldehyde 37% solution	Contact Information: ScienceLab.com, Inc. 14025 Smith Rd. Hawthorne, NJ 07036
Catalog Codes: SLF1426	US Sales: 1-800-991-7247
CAS#: Mixture.	International Sales: 1-281-441-4400
RTCS: LP8925000	Order Online: ScienceLab.com
TSCA: TSCA 8(b) inventory: Formaldehyde; Methyl alcohol; Water	CHEMTREC (24HR Emergency Telephone), call: 1-800-224-9300
CfR: Not applicable.	International CHEMTREC, call: 1-703-527-3887
Synonym: Formalin	For non-emergency assistance, call: 1-281-441-4400
Chemical Name: Formaldehyde	
Chemical Formula: HCHO	

Section 2: Composition and Information on Ingredients		
Composition:		
Name	CAS #	% by Weight
Formaldehyde	50-00-0	38.5-38
Methyl alcohol	67-56-1	10-15
Water	7732-18-5	47-53.5

Toxicological Data on Ingredients: Formaldehyde: ORAL (LD50): Acute: 100 mg/kg [Rat], 42 mg/kg [Mouse], 260 mg/kg [Guinea pig]. MIST (LC50): Acute: 454000 mg/m 4 hours [Mouse]. Methyl alcohol: ORAL (LD50): Acute: 5628 mg/kg [Rat]. DERMAL (LD50): Acute: 15000 mg/kg [Rabbit]. VAPOR (LC50): Acute: 64000 ppm 4 hours [Rat].

Section 3: Hazards Identification	
Potential Acute Health Effects:	Very hazardous in case of eye contact (irritant). Hazardous in case of skin contact (irritant, sensitizer, permeator), of eye contact (corrosive). Slightly hazardous in case of skin contact (corrosive). Severe over-exposure can result in death. Inflammation of the eye is characterized by redness, watering, and itching.
Potential Chronic Health Effects:	Hazardous in case of skin contact (sensitizer). CARCINOGENIC EFFECTS: Classified A2 (Suspected for human.) by ACGIH, 2A [Human] (Suspected for human.) by IARC. [Formaldehyde] MUTAGENIC EFFECTS: Mutagenic for bacteria and/or yeast. [Formaldehyde] Mutagenic for bacteria and/or yeast. [Formaldehyde] Mutagenic for mammalian somatic cells. [Methyl alcohol]

Other Resources

1. "Occupational Exposure to Hazardous Chemicals in Laboratories." California Code of Regulations (CCR) Title 8, Section 5191;
2. Standard Operating Procedures (SOPs) for handling toxic chemicals (*Appendix D*);
3. General information on the signs and symptoms associated with exposure to hazardous substances used in the laboratory or facility
 - Identity labels, showing contents of containers (including waste receptacles) and associated hazards;
 - Label hazardous waste containers. See the EHS website for information about Waste Accumulation Storage Tracking (WASTe)(<http://ehs.ucmerced.edu/hazardous-materials/waste/online-hazardous-waste-tag>)
 - Warnings at areas or equipment where special or unusual hazards exist (e.g., particularly hazardous substances);
4. Procedures to follow in case of an emergency; including call 9-911, inform your supervisor, and notify EH&S within 8 hours.
 - Emergency telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers; and
 - Location signs for safety showers, eyewash stations, other safety and first aid equipment, exits and areas where food and beverage consumption and storage are permitted.

7.3 Classes of Hazardous Chemicals

Identification & Classification of Hazardous Chemicals

Chemicals can be divided into several different hazard classes. The hazard class will determine how these materials should be stored and handled and what special equipment and procedures are needed to use them safely. Each chemical container, whether supplied by a vendor or produced in the laboratory, must include labels that clearly identify the hazards associated with that chemical. In addition to specific chemical labels, hazard information for specific chemicals can be found by referencing the Safety Data Sheet (SDS) for that chemical.

Rooms containing hazardous chemicals must be labeled with the name of the PI responsible for the space, a contact phone number, protective equipment that must be worn in that lab, and any hazards found in the lab. An example placard is shown in figure 7.1.

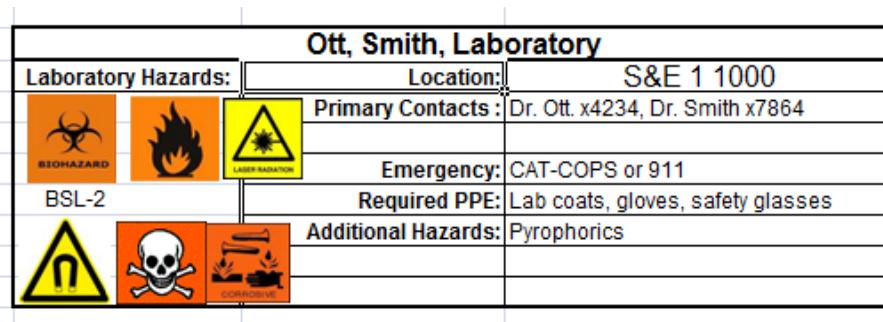


Figure 7.1 - Door Posting

It is essential that all laboratory workers understand the types of hazards, recognize the routes of exposure, and

are familiar with the major hazard classes of chemicals. In many cases, the specific hazards associated with new compounds and mixtures will not be known, so it is recommended that all chemical compounds be treated as if they were potentially harmful and to use appropriate eye, inhalation and skin protection equipment.

FLAMMABILITY HAZARDS

A number of highly flammable substances are in common use in campus laboratories. Flammable liquids include those chemicals that have a flashpoint of less than 100 degrees Fahrenheit. These materials must be stored in flammable storage cabinets in aggregate quantities of 10 gallons or more. Flame-resistant laboratory coats must be worn when working with large quantities (4 liters or more) of flammable materials and/or with procedures where a significant fire risk is present (e.g., when working with open flame, etc.). These materials can constitute a significant immediate threat and should be treated with particular care, even though the use of these materials is fairly common in the laboratory setting. Particular attention should be given to preventing static electricity and sparks when handling flammable liquids.

REACTIVITY HAZARDS

Reactive and explosive substances are materials that decompose under conditions of mechanical shock, elevated temperature, or chemical action, and release of large volumes of gases and heat. Some materials, such as peroxide formers, may not be explosive, but may form explosive substances over time. These substances pose an immediate potential hazard and procedures which use them must be carefully reviewed. These materials must also be stored in a separate flame-resistant storage cabinet or, in many cases, in laboratory grade refrigerator or freezer that are designed for flammable and reactive chemicals. Pyrophoric chemicals are a special classification of reactive materials that spontaneously combust when in contact with air and require laboratory-specific training. Flame-resistant laboratory coats must always be worn when working with pyrophoric chemicals.

HEALTH HAZARDS

Cal/OSHA uses the following definition for health hazards:

The term ‘health hazard’ includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

The major classes of “hazardous” and “particularly hazardous substances” and their related health and safety risks are detailed below.



Corrosive Substances

As a health hazard, corrosive substances cause destruction of, or alterations in, living tissue by chemical action at the site of contact.

Major classes of corrosive substances include:

- Strong acids – e.g., sulfuric, nitric, hydrochloric and hydrofluoric acids
- Strong bases – e.g., sodium hydroxide, potassium hydroxide and ammonium hydroxide
- Dehydrating agents – e.g., sulfuric acid, sodium hydroxide, phosphorus pentoxide and calcium oxide
- Oxidizing agents – e.g., hydrogen peroxide, chlorine and bromine.



Symptoms of exposure for inhalation include a burning sensation, coughing, wheezing, laryngitis, shortness of breath, nausea, and vomiting. For eyes, symptoms include pain, blood shot eyes, tearing, and blurring of vision. For skin, symptoms may include reddening, pain, inflammation, bleeding, blistering and burns. As a physical hazard, corrosive substances may corrode materials they come in contact with and may be highly reactive with other substances. It is important to review information regarding the materials they may corrode, and their reactivity with other substances, as well as information on health effects. In most cases, these materials should be segregated from other chemicals and require secondary containment when in storage.

Irritants

Irritants are defined as non-corrosive chemicals that cause reversible inflammatory effects on living tissue by chemical action at the site of contact. A wide variety of organic and inorganic compounds, including many chemicals that are in a powder or crystalline form, are irritants. The most common example of an irritant may be ordinary smoke which can irritate the nasal passages and respiratory system. Consequently, eye and skin contact with all laboratory chemicals should always be avoided. Symptoms of exposure can include reddening or discomfort of the skin and irritation to respiratory systems.

Sensitizers

A sensitizer (allergen) is a substance that causes exposed people to develop an allergic reaction in normal tissue after repeated exposure to the substance. Examples of sensitizers include diazomethane, chromium, nickel, formaldehyde, isocyanates, arylhydrazines, benzylic and allylic halides, and many phenol derivatives. Sensitizer exposure can lead to all of the symptoms associated with allergic reactions, or can increase an individual's existing allergies.

Hazardous Substances with Toxic Effects on Specific Organs

Substances included in this category include:

- Hepatotoxins – i.e., substances that produce liver damage, such as nitrosamines and carbon tetrachloride
- Nephrotoxins – i.e., agents causing damage to the kidneys, such as certain halogenated hydrocarbons
- Neurotoxins – i.e., substances which produce their primary toxic effects on the nervous system, such as mercury, acrylamide and carbon disulfide
- Agents which act on the hematopoietic system – e.g., carbon monoxide and cyanides which decrease hemoglobin function and deprive the body tissues of oxygen
- Agents which damage lung tissue – e.g., asbestos and silica.



Symptoms of exposure to these materials vary. Staff working with these materials should review the SDS for the specific material being used and should take special note of the associated symptoms of exposure.

Particularly Hazardous Substances

OSHA recognizes that some classes of chemical substances pose a greater health and safety risk than others. To differentiate this different risk characteristic, OSHA identifies two categories of hazardous chemicals:

1. **hazardous chemicals;** and
2. **particularly hazardous substances.**

Substances that pose such significant threats to human health are classified as "particularly hazardous substances" (PHSs). The OSHA Laboratory Standard and Cal/OSHA regulation require that special provisions be established to prevent the harmful exposure of researchers to PHSs, including the establishment of designated areas for their use.

See UC's Particularly Hazardous Substances Policy (*Appendix E*) for more information, which also includes a list of common particularly hazardous chemicals used inside laboratories.

Particularly hazardous substances are divided into three primary types:

1. **Acute Toxins;**
2. **Reproductive Toxins;** and
3. **Carcinogens.**

Acute Toxins

Substances that have a high degree of acute toxicity are interpreted by OSHA as being substances that "may be fatal or cause damage to target organs as the result of a single exposure or exposures of short duration." The SDS will list H300 as the GHS code. These chemicals, associated chemical waste, and storage containers must be handled with care to prevent cross contamination of work areas and unexpected contact. These chemicals must be labeled as "Toxic." Empty containers of these substances must be packaged and disposed of as hazardous waste without rinsing trace amounts into the sanitary sewer system.

Reproductive Toxins

Reproductive toxins (<http://web.princeton.edu/sites/ehs/labsafetymanual/appa.htm>) include any chemical that may affect the reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogenesis). The SDS will list H340, H341,H360, H361 as the GHS code.

Reproductive toxins can affect the reproductive health of both men and women if proper procedures and controls are not used. For women, exposure to reproductive toxins during pregnancy can cause adverse effects on the fetus; these effects include embryolethality (death of the fertilized egg, embryo or fetus), malformations (teratogenic effects), and postnatal functional defects. For men, exposure can lead to sterility.

Examples of embryotoxins include thalidomide and certain antibiotics such as tetracycline. Women of childbearing potential should note that embryotoxins have the greatest impact during the first trimester of pregnancy. Because a woman often does not know that she is pregnant during this period of high susceptibility, special caution is advised when working with all chemicals, especially those rapidly absorbed through the skin (e.g., formamide). Pregnant women and women intending to become pregnant should consult with their laboratory supervisor and EH&S before working with substances that are suspected to be reproductive toxins.

Carcinogens

Carcinogens are chemical or physical agents that cause cancer. Generally they are chronically toxic substances; that is, they cause damage after repeated or long-duration exposure, and their effects may only become evident after a long latency period. Chronic toxins are particularly insidious because they may have no immediately apparent harmful effects. These materials are separated into two classes:

1. **Select Carcinogens;** and
2. **Regulated Carcinogens.**

Select carcinogens are materials which have met certain criteria established by the National Toxicology

Program or the International Agency for Research on Cancer regarding the risk of cancer via certain exposure routes. (See definition Select Carcinogen.) It is important to recognize that some substances involved in research laboratories are new compounds and have not been subjected to testing for carcinogenicity. The following references (links provided) are used to determine which substances are select carcinogens by Cal/OSHA's classification:

- OSHA Carcinogen List (<http://web.princeton.edu/sites/ehs/labsafetymanual/sec7j.htm>)
- Annual Report on Carcinogens published by the National Toxicology Program (NTP), including all of the substances listed as "known to be carcinogens" and some substances listed as "reasonably anticipated to be carcinogens" (<http://ntp.niehs.nih.gov/index.cfm?objectid=32BA9724-F1F6-975E-7FCE50709CB4C932>)
- International Agency for Research on Cancer (IARC), including all of Group 1 "carcinogen to humans" by the International Agency for Research on Cancer Monographs (IARC) (Volumes 1-48 and Supplements 1-8); and some in Group 2A or 2B, "reasonably anticipated to be carcinogens" by the National Toxicology Program (NTP), and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria: (i) 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/m³; (ii) after repeated skin application of less than 300 mg/kg of body weight per week; or (iii) after oral dosages of less than 50 mg/kg of body weight per day (<http://monographs.iarc.fr/ENG/Classification/crthgr01.php>)
- The SDS will list H350 as the H code.

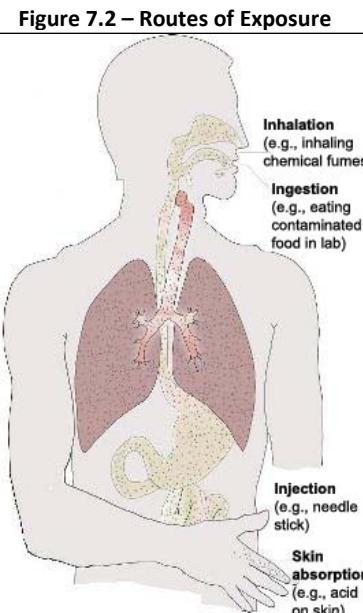
Regulated Carcinogens fall into a higher hazard class and have extensive additional requirements associated with them. The use of these agents may require personal exposure sampling based on usage. When working with Regulated Carcinogens, it is particularly important to review and effectively apply engineering and administrative safety controls as the regulatory requirements for laboratories that may exceed long term (8 hour) or short term (15 minutes) threshold values for these chemicals are very extensive. A complete list of Regulated Carcinogens can be found in *Appendix G*.

7.4 Exposure Control

Introduction

Hazardous chemicals require a carefully considered, multi-tiered approach to ensure safety. There are four primary routes of exposure for chemicals which have associated health hazards (illustrated in Figure 7.2):

1. Inhalation;
2. Absorption (through the skin or eyes);
3. Ingestion; and
4. Injection (skin being punctured by a contaminated sharp object or uptake through an existing open wound).



Of these, the most likely route of exposure in the laboratory is by inhalation. Many hazardous chemicals may affect people through more than one of these exposure modes, so it is critical that protective measures are in place for each of these uptake mechanisms.

Safety Controls

Safety controls are divided into three main classifications:

1. Engineering Controls;
2. Administrative Controls; and
3. Protective Apparel and Equipment.

Elements of these three classes are used in a layered approach to create a safe working environment. The principles of each of these elements are detailed below.

Engineering Controls

Engineering controls include all “built in” safety systems. These controls offer the first line of protection and are highly effective in that they generally require minimal special procedures or actions on the part of the user except in emergency situations. A fundamental and very common example is the laboratory fume hood which is very effective at containing chemical hazards and protecting users from inhalation hazards. Other examples of engineering controls include general room ventilation, flammable material storage units, and secondary containment.

General Laboratory Ventilation

All laboratory rooms in which hazardous materials are used must have fresh air ventilation with 100% of the exhaust venting to the outside; laboratory rooms should not be part of recycled air systems. In cases where this is not desirable, a formal hazard evaluation will be made by EH&S to determine what work can be done in the space and under what special conditions or limitations. Laboratory rooms should be kept at negative pressure compared to public areas to prevent the spread of hazardous vapors. See the University of California Environment, Health and Safety (EH&S) Laboratory Safety Design Guide available in the EH&S office, for additional information on laboratory ventilation.

Fume Hoods - see section 9 for a complete discussion of fume hood use

Other Engineering Controls

In addition to the elements listed above, consideration must be given to providing sufficient engineering controls for the storage and handling of hazardous materials. No more than 10 gallons of flammable chemicals may be stored outside of an approved flammable storage cabinet for the Castle and Science and Engineering 2 building. For refrigerated or frozen storage, flammable and explosive materials must be kept in refrigeration units specifically designed for storing these materials. Generally these units do not have internal lights or electronic systems that could spark and trigger an ignition; additionally, the cooling elements are external to the unit. These units should be labeled with a rating from Underwriters Laboratory or other certifying organization.

Secondary containment must be provided for corrosive and reactive chemicals and is recommended for all other hazardous chemicals. Secondary containment should be made of chemically resistant materials and should be sufficient to hold the volume of at least the largest single bottle stored in the container.

Laboratories that use hazardous materials must contain a sink, kept clear for hand washing to remove any final residual contamination. Hand washing is recommended whenever a staff member who has been working with hazardous materials plans to exit the laboratory or moves to work on a project that does not involve hazardous materials.

ADMINISTRATIVE CONTROLS

Administrative Controls consist of policies and procedures; they are not generally as reliable as engineering controls in that the user has to carefully follow the appropriate procedures and must be fully trained and aware in order to do so. Campus wide policies include not allowing minors or pets into laboratory spaces, laboratory training, PPE, use of tax free ethanol and controlled substances.

Minors in lab policy:

<http://policies.ucmerced.edu/files/media/file/Minors%20in%20Labs%20and%20Shops%20June%202013.pdf> an

Animals in campus buildings policy:

<http://policies.ucmerced.edu/files/media/file/Animal%20Policy.pdf>

Laboratory training policy:

<http://policies.ucmerced.edu/files/media/file/LabSafetyTraining%20June%202013.pdf>

PPE policy:

<http://policies.ucmerced.edu/files/media/file/PersonalProtectiveEquipment%20June%202013.pdf>

EH&S requires that each laboratory have safety procedures, which include safety practices, for any work that involves hazardous materials. In many cases, a general safe operating procedure can be created in consultation with EH&S , for a class of chemicals that have similar properties. For example, a laboratory group may have one set of safety guidelines for using acids in their laboratory if the acids used have similar properties and/or if the significant differences are delineated in the general procedure. In addition to safety procedures, laboratory groups must submit proposed changes in procedures to EH&S for review prior to implementation if these changes could pose an additional or significantly greater hazard than the standard procedure. These reviews are especially important in cases where immediate hazards are present such as large quantities of flammable material, explosives or highly reactive material, or highly toxic substances.

Laboratory groups should also review their operations to minimize the amounts of hazardous substances in use or to replace them with less hazardous alternatives. Attention must also be paid to the appropriate segregation of incompatible materials.

Standard Operating Procedures

Standard operating procedures (SOPs) (*Appendix D*) or Job Safety Analysis (JSAs) that are relevant to safety and health considerations must be developed and followed when laboratory work involves the use of hazardous chemicals (CCR, Title 8, Section 5191 (e)(3)(A)), especially for “particularly hazardous substances” (PHS). SOPs are written instructions that detail the steps that will be performed during a given experimental procedure and include information about potential hazards and how these hazards will be mitigated. SOPs should be written by laboratory personnel who are most knowledgeable and involved with the experimental process. The development and implementation of SOPs is a core component of promoting a strong safety culture in the laboratory and helps ensure a safe work environment.

While general guidance regarding laboratory work with chemicals is contained in this plan, PIs/Laboratory Supervisors are required to develop and implement laboratory-specific SOPs for certain hazardous chemicals and PHS that are used in their laboratories. These SOPs must be submitted and reviewed by EH&S prior to implementation. For certain hazardous chemicals, PHS, or specialized practices, consideration must be given to whether additional consultation with safety professionals is warranted or required.

Circumstances requiring prior approval from the PI/Laboratory Supervisor must also be addressed in laboratory specific SOPs. These circumstances are based on the inherent hazards of the material being used, the hazards associated with the experimental process, the experience level of the worker, and the scale of the experiment. Some examples of circumstances that may require prior approval include working alone in a laboratory, unattended or overnight operations, the use of highly toxic gas of any amount, the use of large quantities of toxic or corrosive gases, the use of extremely reactive chemicals (e.g., pyrophorics, water reactive chemicals), or the use of carcinogens.

UC maintains a website (<http://ehs.ucmerced.edu/>) with tools and resources that may be referenced while developing SOPs, including fact sheets for the use of certain hazardous chemicals, and an SOP Library (<http://ehs.ucmerced.edu/node/75>) or uchsop.com. Please create your SOP at ehs.ucop.edu/radical EH&S is also available to assist with the development of SOPs. SOPs must be developed prior to initiating any experiments with hazardous chemicals or PHS and are to be filed and maintained in the Laboratory Safety Plan where they are available to all laboratory personnel. These are checked at your annual lab safety audit by EH&S.

When drafting an SOP, consider the type and quantity of the chemical being used, along with the frequency of use. TheSafety data sheet (SDS) for each hazardous chemical or PHS that will be addressed in the SOP should be referenced during SOP development. The SDS lists important information that will need to be considered, such as exposure limits, type of toxicity, warning properties, and symptoms of exposure. If a new chemical will be produced during the experiment, an SDS will not necessarily be available. In these cases, the toxicity is unknown and it must be assumed that the substance is particularly hazardous, as a mixture of chemicals will generally be more toxic than its most toxic component.

Laboratory Safety Equipment

New personnel must be instructed in the location of fire extinguishers, safety showers, and other safety equipment *before* they begin work in the laboratory. This training is considered part of the laboratory specific training that all staff members must attend.

Fire Extinguishers

All laboratories working with combustible or flammable chemicals must be outfitted with appropriate fire extinguishers. All extinguishers should be mounted on a wall in an area free of clutter or stored in a fire extinguisher cabinet. Research personnel should be familiar with the location, use and classification of the extinguishers in their laboratory.

Laboratory personnel are not required to extinguish fires that occur in their work areas and should not attempt to do so unless:

- It is a small fire (i.e., small trash can sized fire)
- Appropriate training has been received
- It is safe to do so

Any time a fire extinguisher is used, no matter for how brief a period, the PI/Laboratory Supervisor, or most senior laboratory personnel present at the time of the incident, must immediately report the incident to the health and safety officer. For more information, refer to section 3.

Safety Showers and Eyewash Stations

All laboratories using hazardous chemicals must have immediate access to safety showers with eye wash stations. Access must be available in **10 seconds** or less for a potentially injured individual and access routes must be kept clear. Safety showers must have a minimum clearance of 16 inches from the centerline of the spray pattern in all directions at all times; this means that no objects should be stored or left within this distance of the safety shower. Sink based eyewash stations and drench hoses are not adequate to meet this requirement and can only be used to support an existing compliant system.



In the event of an emergency, individuals using the safety shower should be assisted by an uninjured person to aid in decontamination and should be encouraged to stay in the safety shower for 15 minutes to remove all hazardous material. If clothing is contaminated, it must be removed.

Safety shower/eyewash stations are tested by Facilities Management on a monthly basis.

Any units which do not have a testing date within one month should be reported immediately to the health and safety officer. If an eyewash or safety shower needs repair, call Facilities Management and give the operator the specific location of the defective equipment. Work orders that have been generated as a result of a health and safety deficiency, such as this, must be flagged as "URGENT".

Fire Doors

Many areas of research buildings may contain critical fire doors as part of the building design. These doors are an important element of the fire containment system and should remain closed unless they are on a magnetic self-closing or other automated self-closing system.

Safe Laboratory Habits

As detailed above, a safety program must include layers of policies and protective equipment to allow for a safe working environment, but to achieve effectiveness, a number of fundamental elements must become basic working habits for the research community. Some of these elements are detailed below:

Personal Protective Equipment:

- Wear closed-toe shoes and full length pants, or equivalent, at all times when in the laboratory.
- Utilize appropriate PPE while in the laboratory and while performing procedures that involve the use of hazardous chemicals or materials.
- Confine long hair and loose clothing.
- Remove laboratory coats or gloves immediately on significant contamination, as well as before leaving the laboratory.
- Avoid use of contact lenses in the laboratory unless necessary. If they are used, inform supervisor so special precautions can be taken.
- Use any other protective and emergency apparel and equipment as appropriate. Be aware of the locations of first aid kits and emergency eyewash and shower station.

Chemical Handling:

- Properly label and store all chemicals. Use secondary containment at all times.
- Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan (Sections 7-12).
- Do not smell or taste chemicals.

- Never use mouth suction for pipetting or starting a siphon.
- Do not dispose of any hazardous chemicals through the sewer system.
- Hazardous materials may only be used in locations authorized by the university.
- Be prepared for an accident or spill and refer to the emergency response procedures for the specific material. Procedures should be readily available to all personnel. Information on minor chemical spill mitigation may also be referenced in *Appendix P*. For general guidance, the following situations should be addressed:
 - Eye Contact: Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention
 - Skin Contact: Promptly flush the affected area with water and remove any contaminated clothing. If symptoms persist after washing, seek medical attention

Equipment Storage and Handling:

- Store laboratory glassware with care to avoid damage. Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur.
- Use certified fume hoods, glove boxes, or other ventilation devices for operations which might result in release of toxic chemical vapors or dust. Preventing the escape of these types of materials into the working atmosphere is one of the best ways to prevent exposure.
- Keep hood closed when you are not working in the hood.
- Do not use damaged glassware or other equipment.
- Do not use uncertified fume hoods or glove boxes for hazardous chemical handling.
- Avoid storing materials in hoods.
- Do not allow the vents or air flow to be blocked.

Laboratory Operations:

- Keep the work area clean and uncluttered.
- Seek information and advice about hazards, plan appropriate protective procedures, and plan positioning of equipment before beginning any new operation.
- If unattended operations are unavoidable, and have been approved by the PI/Laboratory Supervisor, place an appropriate sign on the door, leave lights on, and provide for containment of toxic substances in the event of failure of a utility service (such as cooling water).
- Be alert to unsafe conditions and ensure that they are corrected when detected.
- Research staff and students should never work alone on procedures involving hazardous chemicals, biological agents, or other physical hazards.
- Do not engage in distracting behavior such as practical jokes in the laboratory. This type of conduct may confuse, startle, or distract another worker.

Food/Drink:

- Do not eat, drink, smoke, chew gum, or apply cosmetics in areas where laboratory chemicals are present; wash hands before conducting these activities.
- Do not store, handle, or consume food or beverages in storage areas, refrigerators, glassware or utensils which are also used for laboratory operations.
- Wash areas of exposed skin well before leaving the laboratory.

7.5 Exposure Assessment

Regulatory Overview

It is UC policy to comply with all applicable health, safety and environmental protection laws, regulations and requirements. Cal/OSHA requires that all employers “*measure an employee’s exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance exceed the action level (or in the absence of an action level, the exposure limit).*” Repeated monitoring may be required if initial monitoring identifies employee exposure over the action level or exposure limit.

Cal/OSHA regulates Permissible Exposure Limits (PELs) for airborne contaminants to which “*nearly all workers may be exposed daily during a 40-hour workweek for a working lifetime (of 40 years) without adverse effect*”, and are based upon an 8-hour Time-Weighted Average (TWA) exposure. Thus, the PELs are the maximum permitted 8-hour TWA concentration of an airborne contaminant without the use of respiratory protection. Cal/OSHA has also defined Short Term Exposure Limits (STELs) as the maximum TWA exposure during any 15 minute period, provided the daily PEL is not exceeded and Ceiling (C) exposures that shall not be exceeded at any time.

Cal/OSHA has listed established PELs, STELs and Ceiling exposures for chemical contaminants identified in CCR Title 8 Section 5155 (Airborne Contaminants) Table AC-1 (<http://www.dir.ca.gov>Title8/ac1.pdf>). In the absence of a published Ceiling limit, Cal/OSHA requires employee exposure to concentrations above the PEL be controlled to prevent harmful effects. Further, Cal/OSHA has promulgated specific standards covering several regulated carcinogens, which may include an Action Level (AL), triggering medical surveillance requirements or the imposition of a specific Excursion Limit (such as for asbestos) with a unique measurement of the duration of an exposure.

Additionally, the Safe Drinking Water and Toxic Enforcement Act of 1986 requires Cal/EPA to publish annually a list of Proposition 65 chemicals known to the State to cause cancer or other reproductive toxicity (http://www.oehha.ca.gov/prop65/prop65_list/files/P65single061110.pdf).

Exposure Assessment Overview

All UC employees require protection from exposure to hazardous chemicals above PELs, STELs and Ceiling concentrations. Cal/OSHA requires the person supervising, directing or evaluating the exposure assessment monitoring be competent in the practice of industrial hygiene. Thus, exposure assessment should be performed only by representatives of EH&S and not the PI/Laboratory Supervisor. General questions regarding exposure assessment or the Industrial Hygiene Program can be directed to your health and safety officer.

Minimizing an exposure may be accomplished using a combination of engineering controls, administrative controls and personal protective equipment, listed in order of priority. Assessing exposure to hazardous chemicals may be accomplished through a number of methods performed by EH&S, including employee interviews, visual observation of chemical use, evaluation of engineering controls, use of direct reading instrumentation, or the collection of analytical samples from the employee’s breathing zone. Personal exposure assessment will be performed under either of the following situations:

1. EH&S determines whether an exposure assessment is warranted based on chemical inventories, review of Standard Operating Procedures (SOPs), types of engineering controls present, laboratory inspection results and/or review of the annual PPE Assessment Tool; or

2. User of a hazardous chemical has concern or reason to believe exposure is not minimized or eliminated through use of engineering controls or administrative practices (such as transfer of chemical through double needle performed entirely in a fume hood) and the potential for exposure exists. The user should then inform his or her PI/Laboratory Supervisor, who will in turn contact the EH&S Industrial Hygiene Program, EH&S Radiation Safety Division, EH&S Injury Prevention Division, or UC's Occupational Health Facility (OHF). EH&S and OHF will then determine the best course of action in assessing employee exposure, including visual assessment, air monitoring, medical evaluation, examination, or medical surveillance.

In event of any serious injury or exposure, including chemical splash involving dermal or eye contact, immediately call **9-911** from a campus phone or cell phone and obtain medical treatment immediately. Do not wait for an exposure assessment to be performed before seeking medical care.

EXPOSURE ASSESSMENT PROTOCOL – NOTIFICATION TO EMPLOYEES OR EMPLOYEE REPRESENTATIVES AND RIGHT TO OBSERVE MONITORING

The EH&S Industrial Hygiene Program conducts exposure assessments for members of the campus community. Employees have a right to observe testing, sampling, monitoring or measuring of employee exposure. They are also allowed access to the records and reports related to the exposure assessment. Exposure assessments may be performed for hazardous chemicals, as well as for physical hazards including noise and heat stress to determine if exposures are within PELs or other appropriate exposure limits that are considered safe for routine occupational exposure. General protocol in conducting an exposure assessment may include any of the following:

1. Employee interviews;
2. Visual observation of chemical usage and/or laboratory operations;
3. Evaluation of simultaneous exposure to multiple chemicals;
4. Evaluation of potential for absorption through the skin, mucus membranes or eyes;
5. Evaluating existing engineering controls (such as measuring face velocity of a fume hood);
6. Use of direct reading instrumentation; and
7. Collection of analytical samples of concentrations of hazardous chemicals taken from the employees breathing zone, or noise dosimetry collected from an employee's shirt collar or various forms of radiation dosimetry.

If exposure monitoring determines an employee exposure to be over the action level (or the PEL) for a hazard for which OSHA has developed a specific standard (e.g., lead), the medical surveillance provisions of that standard shall be followed. It is the responsibility of the PI/Laboratory Supervisor to ensure that any necessary medical surveillance requirements are met. When necessary, EH&S will make recommendations regarding adjustments engineering controls or administrative procedures to maintain exposure below any applicable PEL. Where the use of respirators is necessary to maintain exposure below permissible exposure limits, UC will provide, at no cost to the employee, the proper respiratory equipment and training. Respirators will be selected and used in accordance with the requirements of CCR Title 8 Section 5144 (<http://www.dir.ca.gov>Title8/5144.html>) and the University's Respiratory Protection Program.

In assessing exposure to hazardous chemicals for which Cal/OSHA has not published a PEL, STEL or Ceiling exposure, EH&S defers to the Threshold Limit Values (TLVs) established by the American Conference of Governmental Industrial Hygienists (ACGIH) or the Recommended Exposure Limits (RELS) established by the

National Institute of Occupational Safety & Health (NIOSH). Please contact your health and safety officer for more information regarding these chemicals.

NOTIFICATION

The Industrial Hygiene Program will promptly notify the employee and his/her PI/Laboratory Supervisor of the results in writing (within 15 working days or less if required) after the receipt of any monitoring results. The Industrial Hygiene Program will establish and maintain an accurate record of any measurements taken to monitor exposures for each employee. Records, including monitoring provided by qualified vendors, will be managed in accordance with CCR Title 8 Section 3204 “Access to Employee Exposure and Medical Records” (<http://www.dir.ca.gov>Title8/3204.html>).

EXPOSURE ASSESSMENT USE TO DETERMINE AND IMPLEMENT CONTROLS

EH&S and the Occupational Health Facility (OHF) will use any of the following criteria to determine required control measures to reduce employee's occupational exposure:

1. Verbal information obtained from employees regarding chemical usage;
2. Visual observations of chemical use or laboratory operations;
3. Evaluation of existing engineering control measures or administrative practices;
4. Recommendations expressed in Safety data sheets;
5. Regulatory requirements of Cal/OSHA;
6. Recommendations from professional industrial hygiene organizations;
7. Direct reading instrumentation results;
8. Employee exposure monitoring results; and/or
9. Medical evaluation, examination and/or surveillance findings.

Particular attention shall be given to the selection of safety control measures for chemicals that are known to be extremely hazardous. Per Cal/OSHA CCR Title 8 Section 5141 “Control of Harmful Exposure to Employees” (<http://www.dir.ca.gov>Title8/5141.html>), the control of harmful exposures shall be prevented by implementation of control measures in the following order:

1. Engineering controls, whenever feasible;
2. Administrative controls whenever engineering controls are not feasible or do not achieve full compliance and administrative controls are practical; and
3. Personal protective equipment, including respiratory protection, during:
 - a. the time period necessary to install or implement feasible engineering controls
 - b. when engineering and administrative controls fail to achieve full compliance
 - c. in emergencies.

Medical Evaluation

All employees, student workers, medical health services volunteers, or laboratory personnel who work with hazardous chemicals shall have an opportunity to receive a free medical evaluation, including supplemental examinations which the evaluating physician determines necessary, under the following circumstances:

1. Whenever an employee develops signs or symptoms associated with a hazardous chemical to which an employee may have been exposed in a laboratory;
2. Where personal monitoring indicates exposure to a hazardous chemical is above a Cal/OSHA Action Level (AL) or Permissible Exposure Limit (PEL) or recommended exposure levels established by the National Institute for Occupational Safety & Health (NIOSH) or the American Conference of Governmental Industrial Hygienists (ACGIH) in the event Cal/OSHA has not established an AL or PEL for a particular hazardous chemical;
3. Whenever an uncontrolled event takes place in the work area such as a spill, leak, explosion, fire, etc., resulting in the likelihood of exposure to a hazardous chemical; or
4. Upon reasonable request of the employee to discuss medical issues and health concerns regarding work-related exposure to hazardous chemicals.

All work-related medical evaluations and examinations will be performed under the direction of UC's Occupational Health Facility (OHF) by licensed physicians or staff under the direct supervision of a licensed physician. Evaluations and examinations will be provided without cost to the employee, without loss of pay, and at a reasonable time and place.

Any laboratory employee or student worker who exhibits signs and symptoms of adverse health effects from work-related exposure to a hazardous chemical should report to OHF immediately for a medical evaluation. Signs and symptoms can be found on the Safety Data Sheet and may include shortness of breath, coughing, blue lips, etc.

Refer to UC's Injury & Illness Prevention Program (IIPP) (Section 1 of this document) for procedures on how to obtain medical evaluation under the above-listed circumstances.

Information to Provide to the Clinician

At the time of the medical evaluation, the following information shall be provided to OHF:

1. Personal information such as age, weight and campus employee ID number;
2. Common and/or IUPAC name of the hazardous chemicals to which the individual may have been exposed;
3. A description of the conditions under which the exposure occurred;
4. Quantitative exposure data, if available;
5. A description of the signs and symptoms of exposure that the employee is experiencing, if any;
6. A copy of the Safety data sheet (SDS) of the hazardous chemical in question;
7. History of exposure including previous employment and non-occupational (recreational) hobbies; and
8. Any additional information helpful to OHF in assessing or treating an exposure or injury such as a biological component of exposure or existence of an antitoxin.



Physician's Written Opinion

For evaluation or examinations required by Cal/OSHA, the employer shall receive a written opinion from the examining physician which shall include the following:

1. Recommendation for further medical follow-up;
2. Results of the medical examination and any associated tests, if requested by the employee;
3. Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical found in the workplace; and
4. A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

Confidentiality & Individual's Access to Personal Medical Records

All patient medical information is protected by California and federal law and is considered strictly confidential. OHF is prohibited from disclosing any patient medical information that is not directly related to the work-related exposure under evaluation and should not reveal any diagnosis unrelated to exposure. Any patient information disclosed by OHF to the employee's supervisor will be limited to information necessary in assessing an employee's return to work, including recommended restrictions in work activities, if any. Any patient information disclosed by OHF to EH&S will be limited to information necessary to develop a course of exposure monitoring, or perform hazard assessments and incident investigations, if appropriate. OHF will otherwise disclose patient medical information only as required by California and Federal law, such as for Worker's Compensation Insurance claims. Each employee has the right to access his/her own personal medical and exposure records. OHF will provide an employee with a copy of his/her medical records upon written request.

Medical Surveillance

Medical surveillance is the process of using medical examinations, questionnaires and/or biological monitoring to determine potential changes in health as a result of exposure to a hazardous chemical or other hazards. Certain Cal/OSHA standards require clinical examination as part of medical surveillance when exposure monitoring exceeds an established Action Level or PEL.

OHF and/or outside vendors may provide medical surveillance services. Medical surveillance is required of employees who are routinely exposed to certain hazards as part of their job description (such as asbestos) and may be offered to other employees based upon quantifiable or measured exposure. Examples of hazards that are monitored through the medical surveillance program may include:

- Asbestos
- Beryllium
- Formaldehyde
- Lead
- Methylene Chloride
- Noise (Hearing Conservation Program)
- Radioactive Chemicals (Bioassay Program)
- Respirator Use (Respirator Protection Program)
- Other Particularly Hazardous Substances

Individuals with questions regarding work-related medical surveillance are encouraged to contact their health and safety officer for more information.

7.6 Training

EMPLOYEE INFORMATION AND TRAINING

INTRODUCTION

Effective training is critical to facilitate a safe and healthy work environment and prevent laboratory accidents. Employee training on specific workplace hazards must be provided at the time of initial assignment, whenever a new hazard is introduced into the workplace, and whenever employees may be exposed to hazards in other work areas. Laboratory Safety Fundamentals is required for anyone working in a lab, before work begins. All PIs/Laboratory Supervisors must participate in formal safety training and ensure that all their employees have appropriate safety training before working in a laboratory. Additional employee training is required whenever a new hazard is introduced into the work environment, and must be provided within 30 days of receiving the SDS or other safety information. All training must be in the appropriate language, educational level, and vocabulary for laboratory personnel. The EH&S Training Program provides both classroom and online training to help meet this requirement. View the current schedule at <http://ehs.ucmerced.edu/training/lab-safety-training-schedule>. Register for classes at <http://ehs.ucmerced.edu/node/43> and follow the instructions listed.

Types of Training

All laboratory personnel must complete general safety training before:

1. Beginning work in the laboratory;
2. Prior to new exposure situations; and
3. As work conditions change.

Refresher training is also required for all laboratory personnel. Most classes are valid for 3 years. Exceptions include bloodborne pathogens (1 year) and radiation (2 years). EH&S offers general classroom and online training, plus resource materials to assist laboratories in implementing laboratory-specific training.

GENERAL LABORATORY SAFETY TRAINING

Anyone working in a laboratory is required to complete General Laboratory Safety training prior to beginning work, which includes:

- Review of laboratory rules and regulations, including the Chemical Hygiene Plan (Lab Safety Plan).
- Recognition of laboratory hazards
- Use of engineering controls, administrative controls and personal protective equipment to mitigate hazards
- Exposure limits for hazardous chemicals
- Signs and symptoms associated with exposures to hazardous chemicals
- Chemical exposure monitoring
- Review of reference materials (e.g., SDS) on hazards, handling, storage and disposal of hazardous chemicals
- Procedures for disposing of hazardous chemical waste
- Fire safety and emergency procedures
- Information required by Ca. Code of Regulations, Section 3204 regarding access to employee exposure and medical records (annually required)

All employees must take the following basic laboratory classes provided by EH&S as appropriate for their employment status:

- **Laboratory Safety Fundamentals** – for anyone working in a laboratory
- **Hazmat Spill Response** – for anyone working in a laboratory
- **Fire Safety – Labs** – for anyone working in a laboratory

General laboratory safety training requirements are summarized on the EH&S Safety Training Matrix for Laboratory Personnel (*Appendix J*). Additional information can be obtained on the EH&S website <http://ehs.ucmerced.edu/training/safety-training-topics>

LABORATORY-SPECIFIC TRAINING

PIs/Laboratory Supervisors must also provide laboratory or job-specific training. Topics that require specific training include:

- Location and use of the Laboratory Safety Plan, IIPP, SDS(s) and other regulatory information
- Review of IIPP and Emergency Management Plan, including location of emergency equipment and exit routes
- Specialized equipment
- Standard Operating Procedures
- Specialized procedures and protocols
- Particularly Hazardous Substances including physical and health hazards, potential exposure, medical surveillance, and emergency procedures
- The chance to ask questions.

Prior approval may be required for certain procedures based on safety or other concerns. Activities which require special approval should be listed in the LSPS.

Resources

EH&S has a number of tools available for laboratories to simplify the completion of appropriate training, including:

- Online training modules (<http://ehs.ucmerced.edu/training/safety-training-topics>)
 - Respiratory Protection
 - Laboratory Safety Fundamentals
 - Laser Safety
 - Shipping with Dry Ice
 - Compressed Gases
 - And more to come
- Lab Safety Tips of the Month (<http://ehs.ucmerced.edu/lab-safety-tips>)

EH&S provides additional assistance in planning laboratory-specific training upon request.

Documentation of Training

Accurate recordkeeping is a critical component of health and safety training. Per OSHA regulations, departments or laboratories are responsible for documenting health and safety training, including safety meetings, one-on-one training, and classroom and online training. Documentation should be maintained in the Laboratory Safety Plan. Additional information on recordkeeping can be found in *Chapter 8: Compliance and Enforcement*.

EH&S provides recordkeeping resources: Training History – Individual Employee template (*Appendix K*) and a Training Roster – Site-specific Training template (*Appendix L*).

A training history for all laboratory employees is available to PIs/Laboratory Supervisors upon request. This document can serve as an official record of laboratory safety training conducted by EH&S.

For each laboratory employee, use this document to maintain a history of safety training completed. Be sure to include site-specific training, EH&S training and any off-campus training. Refer to the Laboratory Safety Manual and the Safety Training Curriculum for Laboratory Personnel for direction on the required training topics. This documentation is to be maintained in the Laboratory Safety Manual.																																								
Employee Name:	Supervisor:																																							
Assigned Laboratories:																																								
Each laboratory employee must be made aware of the location and content of the Laboratory Safety Manual. By your signature below, you acknowledge that you have read and understood the contents of the manual, and know how to access it in the laboratory.																																								
Employee Signature:	Date:																																							
<table border="1"> <thead> <tr> <th>Title or Description of Training</th> <th>Provided By</th> <th>Date</th> </tr> </thead> <tbody> <tr><td></td><td></td><td></td></tr> </tbody> </table>		Title or Description of Training	Provided By	Date																																				
Title or Description of Training	Provided By	Date																																						

7.7 Inspections and Compliance

Chemical Safety Inspections

EH&S has a comprehensive chemical safety compliance program to assist laboratories and other facilities that use, handle or store hazardous chemicals to maintain a safe work environment. This program helps to ensure compliance with regulations and to fulfill UC's commitment to protecting the health and safety of the campus community.

As part of this chemical safety program, EH&S conducts annual inspections of laboratories and other facilities with hazardous chemicals to ensure the laboratory is operating in a safe manner and to ensure compliance with all federal, state and university safety requirements. The primary goal of inspection is to identify both existing and potential accident-causing hazards, actions, faulty operations and procedures that can be corrected **before** an accident occurs. EH&S can order the cessation of any activity that is "Immediately Dangerous to Life and Health" (IDLH) until that hazardous condition or activity is abated.

The chemical safety inspection is comprehensive in nature and looks into all key aspects of working with hazardous chemicals. While inspections are a snapshot in time and cannot identify every accident-causing mistake, they do provide important information on the overall operation of a particular laboratory. They can also help to identify weaknesses that may require more systematic action across a broader spectrum of laboratories, and strengths that should be fostered in other laboratories. The complete inspection checklist can be found in *Appendix M*. Specific inspection compliance categories include:

1. Documentation and Training;
2. Hazard Communication (including review of SOPs);
3. Emergency and Safety Information;
4. Fire Safety;
5. General Safety;
6. Use of personal protective equipment (PPE);

7. Housekeeping;
8. Chemical Storage;
9. Fume Hoods;
10. Chemical Waste Disposal and Transport;
11. Seismic Safety; and
12. Mechanical and Electrical Safety.

Planned, focused inspections are also conducted. Examples of these include unannounced PPE inspections. Once the inspection is completed, EH&S issues an Laboratory Inspection Report via the Safety Inspection Tool (SIT) <http://ehs.ucop.edu/sit>. The report identifies deficiencies in the laboratory, both critical and non-critical. Critical deficiencies are those that have the potential to lead to serious injuries or be of critical importance in the event of an emergency. Critical deficiencies must be immediately corrected. Non-critical deficiencies must be corrected within 30-days. A copy of the most recent *Laboratory Inspection Checklist* and *Inspection Report* should be maintained as part of the records inside the Laboratory Safety Plan.

NOTIFICATION AND ACCOUNTABILITY

The compliance program requires that PIs/Laboratory Supervisors and other responsible parties take appropriate and effective corrective action upon receipt of written notification of inspection findings. Critical deficiencies are required to be corrected within 48-hours; non-critical deficiencies must be corrected within 30-days. Failure to take corrective actions within the required timeframe will result in a repeat deficiency finding and an escalation of the notification to the Department Chair, Dean and Vice-Chancellor for Research. Depending on the severity of the deficiency, the EH&S Director, in consultation with the Vice-Chancellor for Research may temporarily suspend research activities until the violation is corrected. In some cases, the PI may be required to provide a corrective action plan to the Laboratory Safety Committee prior to resumption of research activities. Inspection reports will be posted at <http://ehs.ucop.edu/sit>. Any corrective actions by the PI can be documented in the same location.

RECORDKEEPING REQUIREMENTS

Accurate recordkeeping demonstrates a commitment to the safety and health of the UC community, integrity of research, and protection of the environment. EH&S is responsible for maintaining records of inspections, accident investigations, equipment calibration, and training conducted by EH&S staff. Per OSHA regulations, departments or laboratories must document health and safety training, including safety meetings, one-on-one training, and classroom and online training. Additionally, the following records must be retained in accordance with the requirements of state and federal regulations:

1. Accident records;
2. Measurements taken to monitor employee exposures;
3. Chemical Hygiene Plan records should document that the facilities and precautions were compatible with current knowledge and regulations;
4. Inventory and usage records for high-risk substances should be kept;
5. Any medical consultation and examinations, including tests or written opinions required by CCR, Title 8, Section 5191; and
6. Medical records must be retained in accordance with the requirements of state and federal regulations.

Section 8 – Chemical Storage and Inventory Control

This section provides guidelines on chemical storage and inventory control

Chemical Inventories

Each laboratory group is required to maintain a current chemical inventory at <http://ehs.ucmerced.edu/research-safety/chem-inventory> that lists the chemicals and compressed gases used and stored in the labs and the quantity of these chemicals. Specific storage locations must be kept as part of the inventory list to ensure that they can be easily located. Chemicals are barcoded and added to the PI inventory at receiving. The PI must remove spent chemicals from the inventory. The PI must update his/her inventory annually each fall, at a minimum. Chemical inventories are used to ensure compliance with storage limits and fire regulations and can be used in an emergency to identify potential hazards for emergency response operations.

The chemical inventory list should be reviewed prior to ordering new chemicals and only the minimum quantities of chemicals necessary for the research should be purchased. As new chemicals are added to the inventory, each laboratory group must confirm that they have access to the Safety data sheet (SDS) for that chemical. Where practical, each chemical should be dated so that expired chemicals can be easily identified for disposal. Inventory the materials in your laboratory frequently (at least annually) to avoid overcrowding with materials that are no longer useful and note the items that should be replaced, have deteriorated, or show container deterioration. Unneeded and compromised items should be discarded as chemical waste.

Indications for disposal include:

- Cloudiness in liquids
- Color change
- Evidence of liquids in solids, or solids in liquids
- "Puddling" of material around outside of containers
- Pressure build-up within containers
- Obvious deterioration of containers

Access to hazardous chemicals, including toxic and corrosive substances, should be restricted at all times. These materials must be stored in laboratories or storerooms that are kept locked when laboratory personnel are not present. Locked storage cabinets or other precautions are always recommended, and in some cases may be required in the case of unusually toxic or hazardous chemicals. Unusually toxic chemicals may include those that are associated with very low immediately dangerous to life or health (IDLH) conditions. For guidance on locked storage requirements, please contact your health and safety officer.

On termination or transfer of laboratory personnel, all related hazardous materials should be properly disposed of, or transferred to the laboratory supervisor or a designee.

Chemical Labeling

Every chemical found in the laboratory must be properly labeled. Most chemicals come with a manufacturer's label that contains the necessary information, so care should be taken to not damage or remove these labels. Each chemical bottle, including diluted chemical solutions, must be labeled with its contents and the hazards associated with this chemical. It is recommended that each bottle also be dated when received and when opened to assist in determining which chemicals are expired and require disposal. When new chemicals and compounds are generated by laboratory operations, these new chemical bottles must be labeled with the full name (not molecular formula), date, and hazard information; the generator or other party responsible for this chemical should be named on the container so that they may be contacted if questions arise about the container's contents.

Peroxide forming chemicals (e.g., ethers) (*Appendix I*) must be labeled with a date on receipt and on first opening the bottle. These chemicals are only allowed a one year shelf life and should be disposed of as waste in one year. These chemicals can degrade to form shock sensitive, highly reactive compounds and should be stored and labeled very carefully.



Particularly Hazardous Substances require additional labeling. Safety labels are available in S&E the room next to 257, Castle 1201 hallway, or from EH&S. which identify the specific hazard associated with each of these chemicals (carcinogen, reproductive toxin, acute toxin). In addition, the storage area where they are kept must be labeled with the type of hazard. These chemicals should be segregated from less hazardous chemicals to help with proper access control and hazard identification.

Chemical Storage & Segregation

Establish and follow safe chemical storage & segregation procedures for your laboratory.

Storage guidelines are included for materials that are flammable, oxidizers, corrosive, water reactive, explosive and highly toxic. The specific Safety data sheet (SDS) should always be consulted when doubts arise concerning chemical properties and associated hazards. All procedures employed must comply with Cal/OSHA, Fire Code and building code regulations. Always wear appropriate personal protective equipment (e.g., laboratory coat, safety glasses, gloves, safety goggles, apron) when handling hazardous chemicals. Be aware of the locations of the safety showers and emergency eyewash stations. Each laboratory is required to provide appropriate laboratory-specific training on how to use this equipment **prior** to working with hazardous chemicals. Table 8.1 lists chemical safety storage priorities.

Table 8.1 – Chemical Safety Storage Priorities

Keep in mind that most chemicals have multiple hazards and a decision must be made as to which storage area would be most appropriate for each specific chemical. First you have to determine your priorities:

1. **Flammability.** When establishing a storage scheme, the number one consideration should be the flammability characteristics of the material. If the material is flammable, it should be stored in a flammable cabinet.
2. **Isolate.** If the material will contribute significantly to a fire (e.g., oxidizers), it should be isolated from the flammables. If there were a fire in the laboratory and response to the fire with water would exaggerate the situation, isolate the water reactive material away from contact with water.
3. **Corrosivity.** Next look at the corrosivity of the material, and store accordingly.
4. **Toxicity.** Finally, consider the toxicity of the material, with particular attention paid to regulated materials. In some cases, this may mean that certain chemicals will be isolated within a storage area. For example, a material that is an extreme poison but is also flammable, should be locked away in the flammable storage cabinet to protect it against accidental release.

There will always be some chemicals that will not fit neatly in one category or another, but with careful consideration of the hazards involved, most of these cases can be handled in a reasonable fashion.

GENERAL RECOMMENDATIONS FOR SAFE STORAGE OF CHEMICALS

Each chemical in the laboratory must be stored in a specific location and returned there after each use. Acceptable chemical storage locations may include corrosive cabinets, flammable cabinets, laboratory shelves, or appropriate refrigerators or freezers. Fume hoods should not be used as general storage areas for chemicals, as this may seriously impair the ventilating capacity of the hood. Figure 8.2 depicts improper fume hood storage. Chemicals should not be routinely stored on bench tops or stored on the floor.

Laboratory shelves should have a raised lip along the outer edge to prevent containers from falling. Hazardous liquids or corrosive chemicals should not be stored on shelves above eye-level and chemicals which are highly toxic or corrosive should be in unbreakable secondary containers.

Chemicals must be stored at an appropriate temperature and humidity level and should **never** be stored in direct sunlight or near heat sources, such as laboratory ovens. Incompatible materials should be stored in separate cabinets, whenever possible. If these chemicals must be stored in one cabinet due to space limitations, adequate segregation and secondary containment must be ensured to prevent adverse reactions. All stored containers and research samples must be appropriately labeled and tightly capped to prevent vapor interactions and to alleviate nuisance odors. Flasks with cork, rubber or glass stoppers should be avoided because of the potential for leaking.



Figure 8.2 Improper Fume Hood Storage

Laboratory refrigerators and freezers must be labeled appropriately with “No Food/Drink” and must **never** be used for the storage of consumables. Freezers should be defrosted periodically so that chemicals do not become trapped in ice formations. New peroxide formers (e.g., ether) can be stored in a refrigerator designed for flammable storage to slow the formation of peroxides. However, old, open bottles should not be refrigerated as peroxide crystals will precipitate.

FLAMMABLE AND COMBUSTIBLE LIQUIDS

Large quantities of flammable or combustible materials should not be stored in the laboratory. The maximum total quantity of flammable and combustible liquids must not exceed **60 gallons** within a flammable storage cabinet. The maximum quantity allowed to be kept outside a flammable storage cabinet, safety can, or approved refrigerator/freezer is **10 gallons for Castle and Science & Engineering 2**. Only the amounts needed for the current procedure should be kept on bench tops and the remainder should be kept in flammable storage cabinets, explosion proof refrigerators/freezers that are approved for the storage of flammable substances, or approved safety cans or drums that are grounded. Always segregate flammable or combustible liquids from oxidizing acids and oxidizers. Flammable materials must **never** be stored in domestic-type refrigerators/freezers and should not be stored in a refrigerator/freezer if the chemical has a flash point below the temperature of the equipment. Flammable or combustible liquids must not be stored on the floor or in any exit access.

Handle flammable and combustible substances only in areas free of ignition sources and use the chemical in a fume hood whenever practical. Only the amount of material required for the experiment or procedure should be stored in the work area. Always transfer flammable and combustible chemicals from glass containers to glassware or from glass container/glassware to plastic. Transferring these types of chemicals between plastic containers may lead to a fire hazard due to static electricity.

Flammable Storage Sheet

Building codes limit the amount of flammable materials that may be stored in laboratories and the size of containers. Flammable liquids should be stored in approved safety cans or in fire-rated flammable storage cabinets wherever possible.

Flammable Liquids – Maximum Size of Containers

<u>Container Type</u>	<u>Class 1A¹</u>	<u>Class 1B²</u>	<u>Class 1C³</u>
Glass ⁴	1 pint	1 quart	1 gallon
Metal or approved plastic	1 gallon	5 gallon	5 gallon
Safety cans	2 gallon	2 gallon	2 gallon
Metal drums	Contact EH&S for storage requirements		

¹Class 1A – Flash point < 73° F (22.78° C), boiling point < 100° F (37.78° C)

²Class 1B – Flash point < 73° F (22.78° C), boiling point > 100° F (37.78° C)

³Class 1C – Flash point > 73° F (22.78° C), boiling point < 100° F (37.78° C)

⁴Exceptions may be made to this requirement, upon application to EH&S, for storage of Class 1A and 1B liquids; quantities not to exceed 1 gallon.

Safety cans are the safest way to store flammable liquids. They have spring-loaded lids and an internal screen, which prevents combustion of the contents. Large polypropylene (“Nalgene”) containers with stopcocks or valves at the bottom should never be used to store flammable liquids. These valves frequently leak and are unsafe in a fire.

Call EH&S for examples of liquids in different flammable classes

Flammable Liquids – Maximum Quantities*

<u>Location</u>	<u>Max. Amount</u>	<u>Conditions</u>
Open laboratory (including safety cans)	10 gallons	Must abide by above conditions
Fire rated storage Cabinet	60 gallons	

*Article 79 California Fire Code
(1998)

Flammable Storage Refrigerators and Environmental Rooms

Never store flammable liquids in a standard or domestic refrigerator.

If flammable liquids must be refrigerated or cooled they must be kept in an approved “flammable storage” refrigerator or freezer. These units are available from many vendors. Domestic refrigerators have a variety of ignition sources inside the cabinet, such as lights, switches, defrost coils, etc. that could ignite vapors. Flammable storage refrigerators have no ignition sources inside the cabinet. On extremely rare occasions it may be necessary to use an “explosion proof” refrigerator or freezer (i.e., one with no interior or exterior ignition sources).

Refrigerators used for food storage should be labeled with a “Store No Chemicals” label. Refrigerators used for storage of other chemicals should be labeled with “Store No Food” label.

Environmental rooms (cold/warm rooms) have many ignition sources and little or no air circulation from outside. They should never be used for storage of flammable or other hazardous materials. Small quantities of hazardous materials (e.g. 500 ml) may be used in these spaces but they should not be stored there.

Pyrophoric & Water Reactive Substances

Because pyrophoric substances can spontaneously ignite on contact with air and/or water, they must be handled under an inert atmosphere and in such a way that rigorously excludes air and moisture. Some pyrophoric materials are also toxic and many are dissolved or immersed in a flammable solvent. Other common hazards include corrosivity, teratogenicity, or peroxide formation.

Only minimal amounts of reactive chemicals should be used in experiments or stored in the laboratory. These chemicals must be stored as recommended in the SDS. Reactive materials containers must be clearly labeled with the correct chemical name, in English, along with a hazard warning.

Suitable storage locations may include inert gas-filled desiccators or glove boxes; however, some pyrophoric materials must be stored in a flammable substance approved freezer. If pyrophoric or water reactive reagents are received in a specially designed shipping, storage or dispensing container (such as the Aldrich Sure/Seal packaging system), ensure that the integrity of that container is maintained. Ensure that sufficient protective solvent, oil, kerosene, or inert gas remains in the container while pyrophoric materials are stored. Never store reactive chemicals with flammable materials or in a flammable liquids storage cabinet.

Storage of pyrophoric gases is described in the California Fire Code, Chapter 41. Gas cabinets, with remote sensors and fire suppression equipment, are required. Gas flow, purge and exhaust systems should have redundant controls to prevent pyrophoric gas from igniting or exploding. Emergency back-up power should be provided for all electrical controls, alarms and safeguards associated with the pyrophoric gas storage and process systems.

Never return excess reactive chemical to the original container. Small amounts of impurities introduced into the container may cause a fire or explosion. For storage of excess chemical, prepare a storage vessel in the following manner:

1. Dry any new empty containers thoroughly;
2. Insert the septum into the neck in a way that prevents atmosphere from entering the clean dry (or reagent filled) flask;
3. Insert a needle to vent the flask and quickly inject inert gas through a second needle to maintain a blanket of dry inert gas above the reagent;
4. Once the vessel is fully purged with inert gas, remove the vent needle then the gas line. To introduce the excess chemical, use the procedure described in the handling section, below;
5. For long-term storage, the septum should be secured with a copper wire;
6. For extra protection a second same-sized septa (without holes) can be placed over the first; and
7. Use parafilm around the outer septa and remove the parafilm and outer septum before accessing the reagent through the primary septum.

The EH&S *Pyrophoric Liquid Safety* video provides information about the safe handling of pyrophoric chemicals and can be viewed online at: <http://www.youtube.com/watch?v=RaMXwNBAbcx>

OXIDIZERS

Oxidizers (e.g., hydrogen peroxide, ferric chloride, potassium dichromate, sodium nitrate) should be stored in a cool, dry place and kept away from flammable and combustible materials, such as wood, paper, Styrofoam, plastics, flammable organic chemicals, and away from reducing agents, such as zinc, alkaline metals, and formic acid.

PEROXIDE FORMING CHEMICALS

Peroxide forming chemicals (e.g., ethyl ether, diethylether, cyclohexene) should be stored in airtight containers in a dark, cool, and dry place and must be segregated from other classes of chemicals that could create a serious hazard to life or property should an accident occur (e.g., acids, bases, oxidizers). The containers should be labeled with the date received and the date opened. This information, along with the chemical identity should face forward to minimize container handling during inspection. These chemicals must also be tested and documented for the presence of peroxides periodically. Minimize the quantity of peroxide forming chemicals stored in the laboratory and dispose of peroxide forming chemicals before peroxide formation. Refer to Appendix I for specific guidelines and/or contact your health and safety officer with questions.

Carefully review all cautionary material supplied by the manufacturer prior to use. Avoid evaporation or distillation, as distillation removes the stabilizer added to solvents. Ensure that containers are tightly sealed to avoid evaporation and that they are free of exterior contamination or crystallization. **Never** return unused quantities back to the original container and clean all spills immediately.

If old containers of peroxide forming chemicals are discovered in the laboratory, (greater than two years past the expiration date or if the date of the container is unknown), **do not handle the container**. If crystallization is present in or on the exterior of a container, **do not handle the container**. Secure it and contact your health and safety officer for pick-up and disposal.

CORROSIVES

Store corrosive chemicals (i.e., acids, bases) below eye level and in secondary containers that are large enough to contain at least 10% of the total volume of liquid stored or the volume of the largest container, whichever is greater. Acids must always be segregated from bases and from active metals (e.g., sodium, potassium, magnesium) at all times and must also be segregated from chemicals which could generate toxic gases upon contact (e.g., sodium cyanide, iron sulfide).

Specific types of acids require additional segregation. Mineral acids must be kept away from organic acids and oxidizing acids must be segregated from flammable and combustible substances. Perchloric acid should be stored by itself, away from other chemicals. Picric Acid is reactive with metals or metal salts and explosive when dry and must contain at least 10% water to inhibit detonation upon opening.

UC Merced Chemical Compatibility Storage Guidelines

1. **Mineral (Inorganic) Acids** - Examples: hydrochloric acid, sulfuric acid, phosphoric acid, boric acid, and hydrobromic acid.
2. **Oxidizers** - Examples: bromic acid, perchloric acid, chromic acid, nitric acid, many perchlorates, permanganates, bromine, chlorine, fluorine, silver nitrate.
 - Oxidizers should not be stored directly on wooden shelves or on paper shelf liners; spills may react and ignite spontaneously
 - Perchloric acid presents special hazards; it must be isolated from oxidizable materials and dehydrating agents
 - Hypochlorite solutions (e.g., bleach) are oxidizers; however, they will release chlorine gas on contact with acids, so store them separately
3. **Bases/Caustics** - Examples: aqueous ammonia, ammonium hydroxide, potassium hydroxide, and sodium hydroxide.
4. **Organic Solvents/Acids** - Examples: acetone, methanol, isopropyl ether, methylene chloride, carbon tetrachloride, acetic acid, citric acid, benzene, tetrahydrofuran.
 - If space is limited, laboratories may wish to separate flammable and non-flammable organic liquids in flammable storage cabinets
5. **Highly Toxic/Carcinogenic** - Examples: sodium azide, acrolein, arsenic pentoxide, pentachlorophenol, hydrazine, botulinum toxin, acrylamide, methyl isocyanate, phorbol esters.
6. **Pyrophoric Materials** - Examples: diethyl aluminum chloride, lithium, white or yellow phosphorus, trimethyl aluminum.
7. **General "Dry" Laboratory Chemicals** - Examples: This would include many of the relatively innocuous or un-reactive materials commonly found in laboratories.
8. **Gases** - Segregate according to hazard class. Acutely toxic and toxic gases should be stored in gas cabinets or fume hoods. Cylinders should be double-chained to a substantial, fixed surface. Cylinders should be turned off at the cylinder valve when not in use and should be capped when stored. See Section 18 for more information.
9. **Water Reactives** - Examples: sodium, potassium, calcium, aluminum tribromide, calcium oxide, acid anhydrides, and metal hydrides.
10. **Controlled Substances** - Narcotics and other controlled substances should be stored in a secure, locked location such as a drawer or safe. See Section 14 for information.

It is important that all laboratory personnel understand procedures for storage of hazardous materials, including where these materials are kept in the laboratory. Section 8 of the LSPS titled Hazardous Materials Storage and Control indicates dedicated locations for storage of hazardous materials, such as under a fume hood, or in a flammable storage cabinet or other area. Include mineral acids, oxidizers, bases, organics, chemical and radioactive wastes, and other categories of hazardous materials as necessary.

Chemical Abbreviations and Annotations Used on Secondary Containers in this Laboratory



ACIDS: *Corrosive to skin, eyes and respiratory tract*

HCl Hydrochloric
Acid **HF** Hydrofluoric
Acid **TCA** Trichloroacetic
Acid **H₂SO₄**
 Sulfuric Acid

BASES: *Corrosive to skin, eyes and respiratory tract*

KOH Potassium
Hydroxide **NH₃OH**
 Ammonium
Hydroxide **NaOH** Sodium
Hydroxide

FLAMMABLE LIQUIDS: *Fire hazard*

EtOH Ethyl Alcohol
MeOH Methanol
IPA Isopropyl alcohol

TOXIC: *Harmful by ingestion or skin absorption*

DEPC Diethyl pyrocarbonate
DMSO Dimethyl sulfoxide
*Carries hazardous materials through
the skin*

LOW HAZARDS:

SDS Sodium Dodecyl Sulfate, *Detergent*
TAE Tris acetic acid + Ethylenediaminetetra
acetic acid **TBE** Tris boric acid +
Ethylenediaminetetra acetic acid **PBS** Phosphate buffered
saline, *Buffer*
SSC Sodium chloride sodium citric acid
TE Tris Ethylenediaminetetraacetic acid
SSPE Sodium chloride sodium phosphate + Ethylenediaminetetraacetic acid
STET Sodium chloride ethylenediaminetetraacetic acid Tris Triton X-100
TNT Tris sodium chloride Tween-20
TPE Tris phosphoric ethylenediaminetetraacetic
acid **STE/TEN** Sodium chloride tris
ethylenediaminetetraacetic acid **DI** Deionized water

Abbreviations which are used for labeling chemicals should be included in the LSPS created for each laboratory and posted in the laboratory.

SPECIAL STORAGE REQUIREMENTS

Compressed Gas Cylinders

Compressed gas cylinders that are stored in the laboratory must be chained to the wall, with the safety cap in place. The cylinders must be restrained by two chains; one chain must be placed at one third from the top of the cylinder, and the other placed at one third from the bottom of the cylinder (see Figure 8.3). Store liquefied fuel-gas cylinders securely in the upright position. **Cylinders containing certain gases such as acetylene are prohibited from being stored in a horizontal position, including those which contain a water volume of more than 5 liters.** Do not expose cylinders to excessive dampness, corrosive chemicals or fumes.



Figure 8.3 – Cylinders Stored and Chained Correctly

Certain gas cylinders require additional precautions. Flammable gas cylinders must use only flame-resistant gas lines and hoses which carry flammable or toxic gases from cylinders and must have all connections wired. Compressed oxygen gas cylinders must be stored at least 20 feet away from combustible materials and flammable gases.

Gas cylinder connections must be inspected frequently for deterioration and must never be used without a regulator. Never use a leaking, corroded or damaged cylinder and never refill compressed gas cylinders. When stopping a leak between cylinder and regulator, always close the valve before tightening the union nut. The regulator should be replaced with a safety cap when the cylinder is not in use. Move gas cylinders with the safety cap in place using carts designed for this purpose.

Liquid Nitrogen

Because liquid nitrogen containers are at low pressure and have protective rings mounted around the regulator, they are not required to be affixed to a permanent fixture such as a wall. However, additional protection considerations should be addressed when storing liquid nitrogen in a laboratory. The primary risk to laboratory personnel from liquid nitrogen is skin or eye thermal damage caused by contact with the material. In addition, nitrogen expands 696:1 when changing from a cryogenic liquid to a room temperature gas. The gases usually are not toxic, but if too much oxygen is displaced, asphyxiation is a possibility. Always use appropriate thermally insulated gloves when handling liquid nitrogen. Face shields may be needed in cases where splashing can occur.

On-Campus Distribution of Hazardous Chemicals

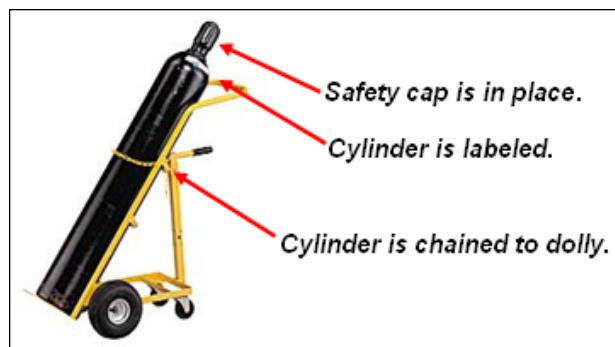
Precautions must be taken when transporting hazardous substances between laboratories. Chemicals must be transported between stockrooms and laboratories in break-resistant, secondary containers such as commercially available bottle carriers made of rubber, metal, or plastic, that include carrying handle(s) and which are large enough to hold the contents of the chemical container in the event of breakage. Refer to UC's Chemistry and Biochemistry Department for information on the "Procedures for Transporting Chemicals" policy (http://www.chemistry.ucla.edu/sites/default/files/safety/sop/Procedures_for_Transporting_Chemicals.pdf)

When transporting cylinders of compressed gases, always secure the cylinder with straps or chains onto a suitable hand truck and protect the valve with a cover cap. Avoid dragging, sliding, or rolling cylinders and use a freight elevator when possible. UCLA offers a “Compressed Cylinder” Fact Sheet (<http://map.ais.ucla.edu/go/1004391>) that may be referenced for the safe transport of compressed gases. Figure 8.4 illustrates correct cylinder transport.

Off-Campus Distribution of Hazardous Chemicals

The transportation of hazardous chemicals and compressed gases over public roads, or by air, is strictly governed by international, federal, and state regulatory agencies, including the U.S. Department of Transportation (DOT) and the International Air Transport Association (IATA). Any person who prepares and/or ships these types of materials must ensure compliance with pertinent regulations regarding training, quantity, packaging, and labeling. Without proper training, it is illegal to ship hazardous materials. Those who violate the hazardous materials shipment regulations are subject to criminal investigation and penalties. UC campus personnel who sign hazardous materials manifests, shipping papers, or those who package hazardous material for shipment, must be trained and certified by EH&S.

Figure 8.4 – Correct Cylinder Transport



Individuals who wish to ship or transport hazardous chemicals or compressed gases off-campus, even when using UC or personal vehicles, must contact your health and safety officer for assistance.

All laboratories should complete Section 8 of the LSPS titled Hazardous Materials Storage and Control.

Section 9 – Fume Hoods and Other Engineering Controls

Fume hoods are the most commonly used local exhaust system on campus. Other methods include vented enclosures for large pieces of equipment or chemical storage, and portable exhaust systems for capturing contaminants near the point of release. Some systems are equipped with air cleaning devices (HEPA filters or carbon absorbers). Exhaust from fume hoods are designed to terminate at least ten feet above the roof deck or two feet above the top of any parapet wall, whichever is higher. The figure on the right displays the key components of a fume hood.

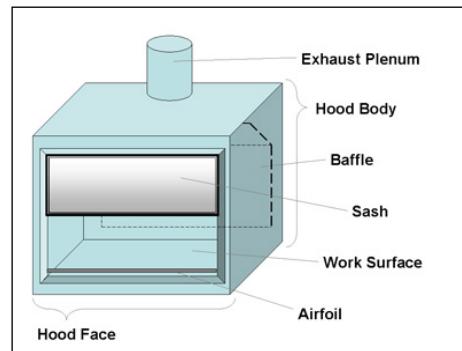


Figure 9.1 – Fume Hood

It is advisable to use a laboratory hood when working with all hazardous substances. In addition, a laboratory hood or other suitable containment device must be used for all work with "particularly hazardous substances." A properly operating and correctly used laboratory hood can reduce or eliminate volatile liquids, dusts and mists. Fume hoods are evaluated for operation and certified by EH&S on an annual basis. These annual evaluations check the fume hood air flow velocity to ensure that the unit will contain hazardous vapors. Data on annual fume hood monitoring will be maintained by EH&S. A complete report of fume hood monitoring data must be kept for one year; summary data must be maintained for 5 years.

Each fume hood should have a current calibration sticker and a marker indicating the highest sash height to be used when working with hazardous materials. Contact EH&S for a hood evaluation if these labels are missing.

Each fume hood must be equipped with at least one type of continuous quantitative monitoring device designed to provide the user with current information on the operational status of the hood. Do not use a hood whose monitor reads "air fail", or less than 100fpm. When hazardous materials are in a fume hood, but it is not under active use (e.g., during an unattended reaction or experiment), the sash should be closed. Fume hoods are not designed for storage of hazardous materials.

Routine maintenance and repairs of fume hoods are conducted by Facilities Management. Hood users may route requests for hood repair directly to Facilities via <http://fmhelp.ucmerced.edu/>. Make sure to indicate that the work order has been "generated as a result of a health and safety deficiency" and mark it "urgent" in order to expedite processing. EH&S does not initiate maintenance but will coordinate with Facilities Management to ensure that it is completed. Upon reported completion by Facilities, EH&S will re-inspect the fume hood following maintenance or repairs. The hood must be cleaned out before facilities will work on the unit. Contact EH&S when the hood is clean and ready for repair.

General Rules for Fume Hood Use

The following general rules should be followed when using laboratory hoods:

1. Fume hoods should not be used for work involving hazardous substances unless they have a certification label that confirms certification has occurred within the past year
2. Always keep hazardous chemicals >6 inches behind the plane of the sash
3. **Never** put your head inside an operating laboratory hood. The plane of the sash is the barrier between contaminated and uncontaminated air
4. Work with the hood sash in the **lowest practical position**. The sash acts as a physical barrier in the event of an accident. Keep the sash closed when not conducting work in the hood
5. Do not clutter your hood with unnecessary bottles or equipment. Keep it clean and clear. Only materials actively in use should be in the hood
6. Do not make any modifications to hoods, duct work, or the exhaust system without first contacting the EH&S office at your campus.
7. Do not use large equipment in laboratory hoods unless the hood is dedicated for this purpose, as large obstructions can change the airflow patterns and render the hood unsafe
8. Shut your sash! For energy efficiency, make sure to shut your sash when the hood is not in use

Laboratory fume hoods are one of the most important pieces of equipment used to protect laboratory and other workers from exposure to hazardous chemicals. Chemical fume hoods should be inspected upon installation, renovation, when a deficiency is reported, or a change has been made to the operating characteristics of the hood. Since fume hoods used for regulated carcinogens (as listed in the UC Particularly Hazardous Substances Policy: appendix E and S) have additional requirements, such as increased face velocity, contact the *EH&S office* at 228-7864 if the intended use changes.

Fume Hood Inspections

Step 1 – Physical Inspection

Evaluates the physical condition of the hood and the materials being used in the hood. This includes checking for:

- Improper storage of materials inside the fume hood
- Use of proper materials
- General hood cleanliness
- Physical damage to the fume hood (e.g., broken sash)
- Fully functioning lighting, fume hood indicator, airflow monitor, and alarm

Step 2 – Hood Performance Inspection

Evaluates the overall hood performance to ensure that it is functioning properly. This involves checking the:

- Average face velocity and set minimum face velocity, which is used to determine the rating of the hood and what the hood can be used for
- Noise generated by the fume hood, to ensure that it is below 85 dB
- If fume hood does not pass inspection, it will be labeled with a “DO NOT USE” sign until it can be repaired.

Glove Boxes and Ventilation Devices

In addition to fume hoods, some laboratories use contained glove box units for working with reactive chemicals under an inert environment, working with very toxic substances in a completely closed system, or for creating a stable, breeze free, system for weighing hazardous or reactive materials. These units can be very effective because they offer complete containment.

Section 10—Personal Protective Equipment

Engineering controls (Section 9) and work practices (Chemical Safety, Section 7) are the most important measures to protect laboratory workers from the hazards they face. However, the variable nature of laboratory work requires that proper personal protective equipment (PPE) be used at all times.

Personal Protective Equipment

Personal protective equipment (PPE) serves as a researcher's last line of defense against chemical exposures and is required by everyone entering a laboratory containing hazardous chemicals. Specific minimum requirements for PPE use for chemical operations are contained in UC Policy (*Appendix R*).

The PPE policy outlines the basic PPE requirements, which include but are not limited to:

- Full length pants and close-toed shoes, or equivalent
- Protective gloves, laboratory coats, & eye protection when working with, or adjacent to, hazardous chemicals
- Flame resistant laboratory coats for high hazard materials, pyrophorics, and ≥ 4 liters of flammables

The primary goal of basic PPE is to mitigate, at a minimum, the hazard associated with exposure to hazardous substances. EH&S policy requires each laboratory to complete a "Hazard Assessment Tool" prior to beginning work and to provide annual updates thereafter. The Lab Hazard Assessment Tool (LHAT), found at <http://ehs.ucop.edu/lhat>, was developed to broadly identify activities involving chemical and other types of hazards and is an effective method of hazard communication. The LHAT captures information on the specific type of hazard(s), the location of the hazard(s), the name of the PI/Laboratory Supervisor who oversees the facility and helps identify the proper PPE that should be used by laboratory personnel to protect themselves against these hazards. Once the required PPE is identified, the laboratory personnel are required to complete training within the LHAT on the use of PPE. Lab members must bring a voucher from the LHAT to be issued any PPE. EHS will issue lab coats and eyewear when presented with a voucher during PPE store hours. The current schedule can be found at <http://ehs.ucmerced.edu/research-safety/ppe>

In some cases, additional, or more protective, equipment must be used. If a project involves a chemical splash hazard, chemical goggles are required; face shields may also be required when working with chemicals that may cause immediate skin damage. Safety goggles differ from safety glasses in that they form a seal with the face, which completely isolates the eyes from the hazard. If a significant splash hazard exists, heavy gloves, protective aprons and sleeves may also be needed. Gloves should only be used under the specific condition for which they are designed, as no glove is impervious to all chemicals. It is also important to note that gloves degrade over time, so they should be replaced as necessary to ensure adequate protection. The EH&S website (www.ehs.merced.edu) provides PPE Selection Guide (<http://ehs.ucmerced.edu/research-safety/personal-protective-equipment-ppe>) to assist in selecting the appropriate glove type for the type of potential hazard.

How to Use and Maintain PPE

Personal protective equipment should be kept clean and stored in an area where it will not become contaminated. Personal protective equipment should be inspected prior to use to ensure it is in good condition. It should fit properly and be worn properly. If it becomes contaminated or damaged, it should be cleaned or repaired when possible, or discarded and replaced.

For additional requirements and information on selection of PPE, see UC Policy (*Appendix R*).

Contaminated Clothing/PPE

In cases where spills or splashes of hazardous chemicals on clothing or PPE occur, the clothing/PPE should immediately be removed and placed in a closed container that prevents release of the chemical. Heavily contaminated clothing/PPE resulting from an accidental spill should be disposed of as hazardous waste. Non-heavily contaminated laboratory coats should be cleaned and properly laundered, as appropriate. Laboratory personnel should **never** take contaminated items home for cleaning or laundering. Persons or companies hired to clean contaminated items must be informed of potentially harmful effects of exposure to hazardous chemicals and must be provided with information to protect themselves.

Respiratory Protection

Typically, respiratory protection is not needed in a laboratory. Under most circumstances, safe work practices, small scale usage, and engineering controls (fume hoods, biosafety cabinets, and general ventilation) adequately protect laboratory workers from chemical and biological hazards. Under certain circumstances, however, respiratory protection may be needed. These can include:

- An accidental spill such as:
 - a chemical spill outside the fume hood
 - a spill of biohazardous material outside a biosafety cabinet
- Performance of an unusual operation that cannot be conducted under the fume hood or biosafety cabinet
- When weighing powdered chemicals or microbiological media outside a glove box or other protective enclosure. Disposable filtering face-piece respirators are generally recommended for nuisance dusts. If the chemicals are toxic, contact EH&S for additional evaluation
- When exposure monitoring indicates that exposures exist that cannot be controlled by engineering or administrative controls
- As required by a specific laboratory protocol or as defined by applicable regulations

Because there are numerous types of respirators available, and each has specific limitations and applications, respirator selection and use requires pre-approval by EH&S. For either required or voluntary use of a respirator, the employee must fill out the Respiratory Hazard Assessment form (*Appendix H*), review it with his/her supervisor, and send the completed form to your health and safety officer. EH&S will contact the employee to evaluate the potential exposure. The review will include an evaluation of the work area and activities for the following:

- Provision of additional ventilation controls or enclosure of the airborne hazard
- Substitution with a less hazardous substance
- Qualitative or quantitative exposure assessment
- Respirator usage

Tasks with potential airborne hazards that cannot be eliminated by engineering or administrative controls will not be authorized by EH&S until affected employees can be incorporated into UC's Respiratory Protection Program.

If EH&S recommends respirator use for a task, the employee must first enroll in the next available Respirator Training and Fit Testing offered through EH&S. The class schedule is available on the EH&S website <http://ehs.ucmerced.edu/training>. For required respirator use, a medical evaluation must be completed before a respirator can be issued. Employees must complete all components prior to starting work that requires respirator use.

Because wearing respiratory equipment places a physical burden on the user, laboratory workers must be medically evaluated prior to wearing respiratory equipment. Certain individuals (e.g., persons with severe asthma, heart conditions, or claustrophobia) may not be medically qualified to wear a respirator. Upon enrollment in Respirator Training and Fit Testing, the employee will be sent the appropriate medical questionnaire. The completed medical questionnaire will be evaluated by a nurse practitioner before the employee proceeds with the training. NOTE: This medical questionnaire is confidential. The employee will be provided additional information on how to contact the nurse practitioner for follow up questions.

After successful completion of the medical evaluation, the employee will be trained and fit tested by EH&S. Training topics include:

- Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protective effect of the respirator
- What the limitations and capabilities of the respirator are
- How to use the respirator effectively in emergency situations, including situations in which the respirator malfunctions
- How to inspect, put on and remove, use, and check the seals of the respirator
- What the procedures are for maintenance and storage of the respirator
- How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators
- The general requirements of the respiratory program

Finally, a qualitative or quantitative fit test is conducted by EH&S for each respirator user. The fit test ensures a proper face to face piece seal for each individual and his/her mask. Fit testing is done in accordance with UC's Respiratory Protection Program and Cal/OSHA regulations (8 CCR 5144) (<http://www.dir.ca.gov/title8/5144.html>).

An annual refresher is required for the medical evaluation, respirator training, and fit testing. In addition to the annual training refresher, a more frequent re-training, fit testing or medical evaluation must be performed when any of the following occur:

- Changes in the workplace or the type of respirator render previous training obsolete
- Inadequacies in the employee's knowledge or use of the respirator indicate that the employee has not retained the requisite understanding or skill
- Any other situation arises in which reevaluation appears necessary to ensure safe respirator use
- Facial scarring, dental changes, cosmetic surgery, or an obvious change in body weight
- An employee reports medical signs or symptoms related to their ability to use a respirator

The use of appropriate PPE should be written into laboratory procedures or safety SOPs (Section 7) and included on the PPE worksheet in the LSPS.

Refer to the PPE worksheet, which is included in the LSPS, for a list of protective equipment available, where it is kept, and when it should be used.

Glove Selection Guide

Latex gloves are used widely in laboratories. Unfortunately, latex gloves offer little protection from commonly used chemicals and up to 20 percent of the population is allergic to latex products.

Latex gloves are only suitable for biological materials, nonhazardous chemicals, very dilute, aqueous solutions of hazardous chemicals, clean area and medical or veterinary applications. In all cases single use, surgical type **nitrile gloves** can be substituted. Nitrile gloves are more durable and provide a clear indication when they tear or break. Nitrile gloves also offer a better set of chemical resistances and are non-allergenic. Staff required to wear latex gloves should receive training on the potential health effects related to latex. If latex is required, hypoallergenic, non-powdered gloves should be used.

Surgical-type gloves are suitable for “**incidental contact**.” This means that no, or very little, actual contact with a chemical in use is anticipated. The gloves are there to prevent chemical contact with the skin when something goes wrong - a spill or splash to the hand, overspray from a dispensing device, etc. As soon as practical after the chemical makes contact with the gloved hand, the gloves must be removed and replaced. Often a glove specified for incidental contact is not suitable for **extended contact** (i.e., when the gloved hands come into substantial contact with or actually may become covered with or immersed in the chemical in use). Generally speaking, a more substantial glove is required for extended contact than for incidental contact.

Double gloving affords a double layer of protection. If the outer glove tears or starts to degrade, the inner glove offers protection until the gloves are removed and replaced. Best practice is to check the outer glove frequently, watching for signs of degradation (change of color, change of texture, etc.), and re-gloving as necessary.

For highly toxic materials and materials easily absorbed through the skin, **Norfoil** gloves (Silver Shield by North Hand Protection, 4H by Safety4, or New Barrier™ brand by Ansell Edmont) are generally recommended. They are somewhat bulky, but dexterity is regained by using a heavier weight (8 mil) disposable nitrile glove over the Norfoil glove. These gloves and others are also available from many vendors.

For non-incidental contact, start with **glove selection charts** provided by glove manufacturers. Different manufacturers use different formulations, and a glove from one firm may not have the same chemical resistance as a similar glove from another firm. Glove selection based on the manufacturers' glove selection charts is often impossible, as only a limited range of chemicals have been tested for use with a specific manufacturer's glove. In particular, many research grade chemicals have not been tested by the various glove manufacturers.

If compatibility information is not available or for any questions, contact EH&S at 228-2EHS. Some manufacturer's charts are available at <http://ehs.ucmerced.edu/research-safety/personal-protective-equipment-ppe>

This document is to be used as a supplement to the Laboratory Hazard Assessment Tool in the selection of appropriate PPE. PPE application should be based on risk assessment, which includes evaluation of the hazard and the procedure used, in consultation with the supervisor and safety officer.

Applicable PPE	Specific type (example)	Characteristics	Applications
Light latex, vinyl or nitrile gloves	Disposable latex gloves	Powdered or un-powdered	Working with biological hazards (known or potentially known infectious materials, including work with animals)
	Disposable nitrile gloves	Puncture, abrasion resistant, protection from splash hazards	Working with biological hazards and chemical splash hazards
	Disposable vinyl gloves	Economical, durable, similar to latex	Working with biological hazards
Light chemical resistant gloves	Natural rubber latex	Chemical resistant, liquid-proof	Working with small volumes of corrosive liquids, organic solvents, flammable organic compounds
Light to heavy chemical resistant gloves	Nitrile gloves	Chemical resistant, good puncture, cut, and abrasion resistance	Apparatus under pressure, air or water reactive chemicals
Heavy chemical resistant gloves	Butyl gloves	High permeation resistance to most chemicals	Large volumes of organic solvents, small to large volumes of dangerous solvents, acutely toxic or hazardous materials
	Viton® II gloves	High permeation resistance to most chemicals	Same as butyl gloves, plus hazardous material spills

Section 11 – Handling Chemical Emergencies

Overview

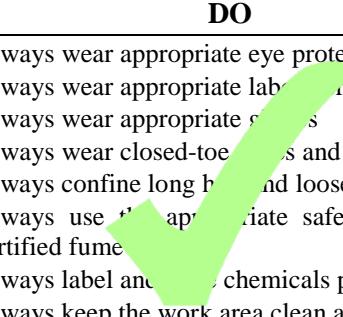
Laboratory emergencies may result from a variety of factors, including serious injuries, fires and explosions, spills and exposures, and natural disasters. All laboratory employees should be familiar with and aware of the location of their laboratory's emergency response plans and safety manuals. **Before beginning any laboratory task**, know what to do in the event of an emergency situation. Identify the location of safety equipment, including first aid kits, eye washes, safety showers, fire extinguishers, fire alarm pull stations, and spill kits. Plan ahead and know the location of the closest fire alarms, exits, and telephones in your laboratory. The Lab Emergency Poster (*Appendix Q*) provides an overview of emergency response procedures for laboratories. It should be posted in each laboratory.

For all incidents requiring emergency response, call UCPD at 9-911 from a campus phone.

Accidents

PIs/Laboratory Supervisors are responsible for ensuring that their employees receive appropriate medical attention in the event of an occupational injury or illness. All accidents and near misses must be reported **within 8 hours to EHS (228-2EHS). If unavailable, report to CAT-COPS (209 228-2677)**. EH&S will conduct an accident investigation and develop recommendations and corrective actions to prevent future accidents. At a minimum, each laboratory must have the following preparations in place:

- Fully stocked first aid kit (minimum contents in Section 1)
- Posting of emergency telephone numbers and locations of emergency treatment facilities, including OHF
- Training of adequate number of staff in basic CPR and first aid
- Training of staff to accompany injured personnel to medical treatment site and to provide medical personnel with copies of SDS(s) for the chemical(s) involved in the incident

Accident Prevention Methods	
DO	DON'T
<ul style="list-style-type: none">• Always wear appropriate eye protection• Always wear appropriate laboratory coat• Always wear appropriate shoes• Always wear closed-toe shoes and long pants• Always confine long hair and loose clothing• Always use appropriate safety controls (e.g., certified fume hood)• Always label and store chemicals properly• Always keep the work area clean and uncluttered	 <ul style="list-style-type: none">• Never enter clothing (e.g., shorts, tank tops, flip-flops, etc.)• Never walk barefoot or in sandals in areas with hazardous materials, physical hazards, or other potential hazards.• Never eat, drink, apply cosmetics, or smoke, or use tobacco products in the laboratory.• Never use electronic devices (e.g., phones, tablets, laptops) in the laboratory.

If an employee has a severe or life threatening injury, call for emergency response. Employees with minor

injuries should be treated with first aid kits as appropriate, and sent to the Occupational Health Facility for further evaluation and treatment. After normal business hours, treatment can be obtained at designated medical centers and emergency rooms.

Serious occupational injuries, illnesses, and exposures to hazardous substances must be reported your health and safety officer within 8 hours. EH&S will report the event to Cal/OSHA, investigate the accident, and complete exposure monitoring if necessary. Serious injuries include those that result in permanent impairment or disfigurement, or require hospitalization. Examples include amputations, lacerations with severe bleeding, burns, concussions, fractures and crush injuries. As soon as PIs/Laboratory Supervisors are aware of a potentially serious incident, they must contact EH&S. For after hours emergencies, call cat-cops.

Fire-Related Emergencies

If you encounter a fire, or a fire-related emergency (e.g., abnormal heating, smoke, burning odor), immediately follow these instructions:

1. Pull the fire alarm pull station **and call 9-911 from a campus phone or 911** from an off-campus or cell phone to notify the Fire Department;
2. Evacuate and isolate the area
 - Use portable fire extinguishers to facilitate evacuation and/or control a small fire (i.e., size of a small trash can), if safe to do so
 - If possible, shut off equipment before leaving
 - Close doors;
3. Remain safely outside the affected area to provide details to emergency responders; and
4. Evacuate the building when the alarm sounds. **It is against state law to remain in the building when the alarm is sounding.** If the alarm sounds due to a false alarm or drill, you will be allowed to re-enter the building as soon as the Fire Department determines that it is safe to do so. **Do not go back in the building until the alarm stops and you are cleared to reenter.**

If your clothing catches on fire, go to the nearest emergency shower immediately. If a shower is not immediately available, then stop, drop, and roll. A fire extinguisher may be used to extinguish a fire on someone. Report any burn injuries to the supervisor immediately and seek medical treatment. Report to your health and safety officer within 8 hours every time a fire extinguisher is discharged.

Chemical Spills

Follow UC Merced chemical storage guidelines (Section 8) to prevent/minimize spills, review emergency preparedness measures, (Section 2) and make sure everyone understands laboratory spill procedures.

Chemical spills can result in chemical exposures and contaminations. Chemical spills become emergencies when:

- The spill results in a release to the environment (e.g., sink or floor drain)
- The material or its hazards are unknown
- Laboratory staff cannot safely manage the hazard because the material is too hazardous or the quantity is too large

Effective emergency response to these situations is imperative to mitigate or minimize adverse reactions when chemical incidents occur. After emergency procedures are completed, all personnel involved in the incident should follow UC chemical exposure procedures as appropriate.

If someone has been splashed:

- Use nearest eyewash/douse showers for eyewashes or hand washes.
- Begin flushing immediately; continue for 15 minutes.
- Seek medical attention if necessary. Call 9-911 and request an ambulance if needed.

The first response for all chemical spills (except HF) is to rinse the affected area with fresh water for at least 15 minutes (the exposed person will need assistance with this). If a shower is not available, wash hoses on many laboratory sinks can be used as a temporary substitute

In the event of a significant chemical exposure or contamination, immediately try to remove or isolate the chemical if safe to do so. When skin or eye exposures occur, remove contaminated clothing and flush the affected area using an eye wash or shower for at least 15 minutes. If a chemical is ingested, drink plenty of water. Obtain medical assistance as indicated. Remember to wear appropriate PPE before helping others. PIs/ Laboratory Supervisors must review all exposure situations, make sure affected employees receive appropriate medical treatment and/or assessment, and arrange for containment and clean-up of the chemical as appropriate.

Prior to responding to any spill, laboratory personnel should be thoroughly familiar with the hazards involved. This information should be included in the laboratory procedures or as a safety SOP. Laboratory employees should only handle small, incidental spills and should never handle a spill without understanding the risks to themselves and others.

The location of Spill Kit(s) and emergency eyewash and safety showers should be included in the LSPS.

Small Chemical Spill

(<1 liter, not highly toxic, not significant fire or environmental hazard, not in public area)

- Evacuate all non-essential persons from the spill area
- If needed, call for medical assistance by dialing **9-911** from a campus phone or 911 from an off-campus or cell phone
- Help anyone who may have been contaminated. Use emergency eyewashes/showers by flushing the skin or eyes for *at least 15 minutes*
- Post someone just outside the spill area to keep people from entering. Avoid walking through contaminated areas
- You must have the proper protective equipment and clean-up materials to clean-up spills. Check the chemical's Safety Data Sheet (SDS) in your laboratory or online (<http://www.ucSDS.com>) for spill clean-up procedures, or call your health and safety officer for advice
- Turn off sources of flames, electrical heaters, and other electrical apparatus, and close valves on gas cylinders if the chemical is flammable
- Confine the spill to a small area. Do not let it spread
- Avoid breathing vapors from the spill. If the spill is in a non-ventilated area, do not attempt to clean it up. Call for emergency personnel to respond and clean up the spill



- Wear personal protective equipment, including safety goggles, gloves, and a laboratory coat or other protective garment to clean-up the spill
- Work with another person to clean-up the spill. Do not clean-up a spill alone
- DO NOT ADD WATER TO THE SPILL
- Use an appropriate kit to neutralize and absorb inorganic acids and bases. For other chemicals, use the appropriate kit or absorb the spill with sorbent pads, paper towels, vermiculite, dry sand, or diatomaceous earth. For mercury spills and specific procedures for all other spills see *Appendix P*.
- Collect the residue and place it in a clear plastic bag. Double bag the waste and label the bag with the contents.
- Create a WASTe tag, and request pickup. (Section12)

Large Chemical Spill (>1 Liter, Spills of any quantity of highly toxic chemicals, or chemicals in public areas or adjacent to drains.)

Large chemical spills require emergency response. Call 9-911 from a campus phone or 911 from an off-campus or cell phone. If the spill presents a situation that is immediately dangerous to life or health (IDLH) or presents a significant fire risk, activate a fire alarm, evacuate the area and wait for emergency response to arrive.

- Remove the injured and/or contaminated person(s) and provide first aid
- Call for emergency medical response
- As you evacuate the laboratory, close the door behind you, and:
 - Post someone safely outside and away from the spill area to keep people from entering
 - Confine the spill area if possible and safe to do so
 - Leave on or establish exhaust ventilation
 - If possible, turn off all sources of flames, electrical heaters, and other electrical equipment if the spilled material is flammable
 - Avoid walking through contaminated areas or breathing vapors of the spilled material
- Any employee with known contact with a particularly hazardous chemical must shower, including washing of the hair as soon as possible unless contraindicated by physical injuries

Highly Toxic Chemical Spills

Do not try to clean up spills of any size that involve these materials. All spills require emergency response:

- | | |
|---|--|
| <ul style="list-style-type: none">• Aromatic amines• Bromines• Carbon disulfide• Cyanides• Ethers | <ul style="list-style-type: none">• Hydrazine• Nitriles• Nitro-compounds• Organic halides |
|---|--|

All laboratory personnel should know:

- Where fire extinguishers are kept and how to use them - Section 3.
- The location, uses and limitations of the laboratory spill kit(s).
- The location of first aid supplies and how to respond to an injury - Section 1.
- Emergency procedures, including Eyewash/Douse shower locations.

Eyewash/Douse Showers

An emergency eyewash/douse shower should be available within 70 feet wherever hazardous materials are used. These may be freestanding units or eyewash units installed near laboratory sinks. Freestanding units are tested by EH&S. Maintain access to emergency eyewash/douse showers at all times – do not store anything around them that could impede access.

The location of emergency eyewash/douse showers should be included in the LSPS.

Laboratory Scale Chemical Spill Kits

Spills can occur wherever chemicals are used. Laboratory personnel can clean up small, incidental spills of hazardous chemicals if they feel comfortable doing so, and if they have the proper equipment and supplies located in the laboratory.

Prior to responding to any spill, laboratory personnel should be thoroughly familiar with the hazards involved. This information should be included in the laboratory procedures or as a safety SOP. Laboratory employees should only handle small, incidental spills and should never handle a spill without understanding the risks to themselves and others.

Laboratory personnel should never clean up:

- Spills that present an immediate hazard (fire, explosion, chemical exposure, etc.)
- Any spill of highly dangerous chemicals
- A moderate or large-scale chemical spill

To respond to a small-scale laboratory spill, laboratories should have a simple spill kit (see sample below). Employees who choose to clean up a spill must wear the proper personal protective equipment (PPE) and wastes must be disposed according to UC Merced Guidelines (Section 12). Spill kits are provided by EH&S.

Kits must include

(at a minimum):

- A storage container with the SPILL KIT LABEL
- PPE – Laboratory workers are responsible for providing appropriate protective equipment, including goggles and gloves.
- Absorbent materials appropriate for chemicals used, bags to contain the waste and UC Merced Hazardous Waste tags.
- Other materials as needed for chemicals used in laboratory.

Gloves and other PPE should be appropriate for laboratory needs, see Section 10 or call EH&S for more information.

Kits should be tailored to laboratory activities, including materials for biological and radiation spills. Consult the individual Laboratory Safety Plan Supplement for more specific information.

Section 12 – Disposing of Chemical Wastes

This section described the minimum requirements for managing hazardous waste in laboratories.

Hazardous Waste Program

The EH&S Hazardous Materials Program manages the shipment and disposal of all hazardous waste generated on campus. Each laboratory employee must comply with the campus Hazardous Waste Management Program requirements and all applicable regulations. A regular pick-up service is provided to most research buildings equipped with wet labs, and a pick-up is available upon request to other locations where hazardous waste is generated. Laboratory personnel are responsible for identifying waste, labeling it, storing it properly in the laboratory, and transporting waste to their designated pick-up location on time. Laboratory clean-outs and disposal of high hazard compounds must be scheduled in advance, and fees for these services are sometimes applied. The PI/Laboratory Supervisor is responsible for coordinating the disposal of all chemicals from his/her laboratories prior to closing down laboratory operations. The UCLA website (www.ehs.ucla.edu) contains a *Hazardous Waste Management Safety* video. Visit the EH&S Online Video page to view this video, and other safety videos: <http://map.ais.ucla.edu/go/1004476>.



Regulation of Hazardous Waste

In California, hazardous waste is regulated by the Department of Toxic Substance Control (DTSC), a division within the California Environmental Protection Agency (Cal/EPA). Federal EPA regulations also govern certain aspects of hazardous waste management, since most of our waste is treated and disposed out of state. These hazardous waste regulations are part of the Resource Conservation and Recovery Act, or RCRA. Local enforcement authority is administered by the Merced County CUPA.

DEFINITION OF HAZARDOUS WASTE

EPA regulations define hazardous waste as substances having one of the following hazardous characteristics:

- Corrosive: pH < 2 or >12.5¹
- Ignitable: liquids with flash point below 60° C or 140° F [e.g. Methanol, Acetone]
- Reactive: unstable, explosive or reacts violently with air or water, or produces a toxic gas when combined with water [e.g. Sodium metal]
- Toxic: Determined by toxicity testing [e.g. Mercury] or waste designation calculations.

The EPA definition of hazardous waste also extends to the following items:

- Abandoned chemicals
- Unused or unwanted chemicals
- Chemicals in deteriorating containers
- Empty containers that have visible residues
- Containers with conflicting labels
- Unlabeled or unknown chemicals

¹ There are additional restrictions on the disposal of substances with a non-neutral pH; see the section on Drain Disposal, below.

Chemicals not in frequent use must be carefully managed to prevent them from being considered a hazardous waste. This is especially true for certain compounds that degrade and destabilize over time and require careful management so that they do not become a safety hazard (see the section below titled “Wastes that Require Special Handling”).

EXTREMELY HAZARDOUS WASTE

Certain compounds meet an additional definition known as “extremely hazardous waste”. This list of compounds includes carcinogens, pesticides, and reactive compounds, among others (e.g., formaldehyde, chloroform, and hydrofluoric acid). The Federal EPA refers to this waste as “acutely hazardous waste”, but Cal/EPA has published a more detailed list of extremely hazardous waste. Both the State and the Federal lists are included in the EH&S list of extremely hazardous waste, found at: <http://map.ais.ucla.edu/go/1002773>. NOTE: While there is some overlap with the list of Particularly Hazardous Substances, such as the examples listed above, the extremely hazardous waste list is specific to the hazardous waste management program.

TRAINING

All personnel who are responsible for handling, managing or disposing of hazardous waste must attend training **prior** to working with these materials. The Hazardous Chemical Waste training, , covers the hazardous waste program requirements and includes training on the container labeling program, or WASTe See the EH&S website (<http://ehs.ucmerced.edu/>) for the training schedule and course description.

WASTE IDENTIFICATION

All the chemical constituents in each hazardous waste stream must be accurately identified by knowledgeable laboratory personnel. This is a critical safety issue for both laboratory employees and the waste technicians that handle the waste once it is turned over to EH&S. Mixing of incompatible waste streams has the potential to create violent reactions and is a common cause of laboratory accidents. If there is uncertainty about the composition of a waste stream resulting from an experimental process, laboratory workers must consult the PI/Laboratory Supervisor, the Chemical Hygiene Officer or the Hazardous Materials Manager. In most cases, careful documentation and review of all chemical products used in the experimental protocol will result in accurate waste stream characterization.

The manufacturer’s SDS provides detailed information on each hazardous ingredient in laboratory reagents and other chemical products, and also the chemical, physical, and toxicological properties of that ingredient. The UC SDS library (<http://www.ucmsds.com>) provides an extensive library of research chemicals. Waste streams that have a large percentage of ingredients listed as proprietary information should be discussed with the Hazardous Materials Program Manager.

LABELING

UC utilizes a system-wide Waste Accumulation Storage Tracking (WASTe) program Information on how to use WASTe is included in the Waste Management for Labs and Laboratory Safety Fundamentals course and online (<http://ehs.ucmerced.edu/hazardous-materials/waste/online-hazardous-waste-tag>).

WASTe (ehs.ucop.edu/WASTe)

How to Create an Account

WASTe accounts are maintained under the PI.

Employees should ascertain if an account has already been established for their PI and associated laboratory(s). If a new account needs to be established, or you need to be added to a PI's account, contact EH&S.

How to Use WASTe

- Once an account has been established, employees can print labels from their laboratory's printer, and then affix the tag to the waste container by sliding it into the plastic envelope provided by EH&S.
- Each label must be completed accurately, and the tag must be updated as the contents of the waste container change. Product names or abbreviations for waste container ingredients should not be used. WASTe tags cannot be photocopied, as each tag has a unique bar code that is used to track that individual container. Employees may save a profile in the program for waste streams that are frequently generated
- Request pickup by checking the box to the left of the entry and clicking the button on the bottom "ready for pickup".
- When waste containers approach the maximum allowable storage period in the laboratory accumulation area, all the contacts for that WASTe account are emailed a reminder to request a pick-up from EH&S. When EH&S collects the waste, the tags are scanned and the containers are entered into the inventory for the campus waste accumulation area and removed from the laboratory inventory.

STORAGE

The hazardous waste storage area in each laboratory is considered a Satellite Accumulation Area (SAA) by the EPA. According to EPA requirements, this area must remain under the control of the persons producing the waste. This means that it should be located in an area that is supervised and is not accessible to the public. Other SAA requirements include:

- Hazardous waste containers must be labeled with an WASTe tag at all times
- Waste must be collected and stored at or near the point of generation
- According to State law, the maximum amount of waste that can be stored in a SAA is 55 gallons of a hazardous waste or 1 quart of extremely hazardous waste. If you reach these volumes for a specific waste stream, you must dispose of the waste within 3 days
- The maximum amount of flammable solvents allowed to be stored in a laboratory is 60 gallons; this figure also includes waste solvents
- All hazardous waste containers in the laboratory must be kept closed when not in use
- Hazardous waste streams must have compatible constituents, and must be compatible with the containers that they are stored in
- Hazardous waste containers must be stored in secondary containment at all times.
- Containers must be in good condition with leak proof lids
- Containers must be less than 90% full
- Dry wastes must be double-bagged in clear, 3-mil plastic bags
- All containers must be labeled with an WASTe tag when the first drop is added.

SEGREGATION

All hazardous materials must be managed in a manner that prevents spills and uncontrolled reactions. Stored chemicals and waste should be segregated by hazard class. Examples of proper segregation are:

- Segregate acids from bases
- Segregate oxidizers from organics
- Segregate cyanides from acids

Segregation of waste streams should be conducted in a similar manner to segregation of chemical products. Refer to *Appendix N* for chemical segregation guidelines.

INCOMPATIBLE WASTE STREAMS

Mixing incompatible waste streams, or selecting a container that is not compatible with its contents, is a common cause of accidents in laboratories and waste storage facilities. Reactive mixtures can rupture containers and explode, resulting in serious injury and property damage. All chemical constituents and their waste byproducts must be compatible for each waste container generated. Waste tags must be immediately updated when a new constituent is added to a mixed waste container, so that others in the laboratory will be aware and manage it accordingly.

Some common incompatible waste streams include:

- Oxidizers added to any fuel can create an exothermic reaction and explode. The most frequent is acids oxidizing flammable liquids. For this reason, all flammable liquids are pH tested before they are consolidated
- Piranha etch solution is a specific waste stream that contains sulfuric acid and hydrogen peroxide, which form a reactive mixture that is often still fuming during disposal. For this waste stream, and other reactive mixtures like it, vented caps are mandatory

WASTES THAT REQUIRE SPECIAL HANDLING

Unknowns

Unlabeled chemical containers and unknown/unlabeled wastes are considered unknowns, and additional fees must be paid to have these materials analyzed and identified. These containers must be labeled with the word “unknown”.

Peroxide Forming Chemicals

Peroxide forming chemicals, or PFCs, include a number of substances that can react with air, moisture or product impurities, and undergo a change in their chemical composition during normal storage. The peroxides that form are highly reactive and can explode upon shock or spark. Peroxides are not particularly volatile and thus tend to precipitate out of liquid solutions. It is particularly dangerous to allow a container of these materials to evaporate to dryness, leaving the crystals of peroxide on the surfaces of the container.

Each container of peroxide forming chemicals should be dated with the date received and the date first opened. There are three classes of peroxide forming chemicals, with each class having different management guidelines. A guide to managing some PFCs commonly found in research labs is provided in *Appendix I*. Since this Appendix does not provide an exhaustive list of PFCs, review the safety information provided by the manufacturer for any chemicals you purchase.

Ensure containers of PFCs are kept tightly sealed to avoid unnecessary evaporation, as this inhibits the

stabilizers that are sometimes added. Visually inspect containers periodically to ensure that they are free of exterior contamination or crystallization. PFC containers must be disposed of prior to expiration date. If old containers of peroxide forming chemicals are discovered in the laboratory, (greater than two years past the expiration date or if the date of the container is unknown), **do not handle the container**. If crystallization is present in or on the exterior of a container, **do not handle the container**. Secure it and contact your health and safety officer for pick-up and disposal.

Dry Picric Acid and Dinitrophenyl Hydrazine

Picric acid (also known as trinitrophenol) and dinitrophenyl hydrazine must be kept hydrated at all times, as it becomes increasingly unstable as it loses water content. When dehydrated, it is not only explosive but also sensitive to shock, heat and friction. Picric acid is highly reactive with a wide variety of compounds (including many metals) and is extremely susceptible to the formation of picrate salts. Be sure to label all containers that contain either of these substances with the date received, and then monitor the water content every 6 months. Add distilled water as needed to maintain a consistent liquid volume.

If old or previously unaccounted for bottles of picric acid or dinitrophenyl hydrazine are discovered, **do not touch the container**. Depending on how long the bottle has been abandoned and the state of the product inside, even a minor disturbance could be dangerous. Visually inspect the contents of the bottle without moving it to evaluate its water content and look for signs of crystallization inside the bottle and around the lid. If there is even the slightest indication of crystallization, signs of evaporation, or the formation of solids in the bottle, **do not handle the container** and contact **your health and safety officer** immediately. Secure the area and restrict access to the container until it can be evaluated by EH&S personnel.

Explosives and Compounds with Shipping Restrictions

A variety of other compounds that are classified as explosives or are water or air reactive are used in research laboratories. These compounds often have shipping restrictions and special packaging requirements. When disposing of these compounds, employees must ensure that they are stored appropriately for transport. Flammable metals must be completely submerged in oil before they are brought to a waste pick-up. Many pyrophoric and reactive compounds can be stabilized using a quenching procedure prior to disposal. Chemicals classified by the Department of Transportation (DOT) as explosives (e.g., many nitro- and azo-compounds) will require special packaging and shipping, and may require stabilization prior to disposal. Consult with the Chemical Hygiene Officer for disposal considerations of these compounds.



MANAGING EMPTY CONTAINERS

Empty containers that held Extremely Hazardous waste must be managed as hazardous waste, and picked up through WASTe. Do not rinse or reuse these containers.

All other hazardous waste containers, if they are less than 5 gallons in size, should either be reused for hazardous waste collection, or should be cleaned and discarded or recycled. Proper cleaning involves triple rinsing the container, with the first rinse collected as hazardous waste. Then the labels should be completely defaced (remove it or mark it out completely). Dispose or recycle rinsed plastic or glass containers as regular trash or in a campus recycling bin. To request a recycling bin, contact your health and safety officer. Clean bottles can be left in the room next to 257 for other labs to use to collect waste.

Empty containers 5 gallons in size or more should be turned in to EH&S or brought to a hazardous waste pick-up.

TRANSPORTATION

It is a violation of DOT regulations to transport hazardous waste in personal vehicles, or to carry hazardous waste across campus streets that are open to the public. As a result, EH&S provides pick-up services for all hazardous waste generators. Special pick-ups and laboratory clean-outs are available upon request for large volumes (more than 20 containers or 20 gallons).

Inspect all containers to make sure that they are safe to transport. Verify that each container has an accurate waste tag, and the containers are clean and free of residue and do not show any signs of bulging, fuming, or bubbling. Containers should be segregated with secondary containment. As a best practice, employees should wear eye protection and closed toe shoes (and carry gloves with them) when transporting waste.

DISPOSAL

Frequent disposal will ensure that waste accumulation areas in labs are managed properly, and that maximum storage volumes are not exceeded. Federal regulation states that hazardous chemical waste can be stored in a laboratory for up to 180 days. Once a waste container is 90% full or it is near the 180 day time limit, it should be disposed on the next designated pick-up. Once an experiment or process is completed, all partially filled containers should be disposed on the next scheduled pick-up.

Acceptable Wastes for a Routine Pick Up

EH&S accepts the following materials at a routine pick-up:

- 20 containers or less of research generated waste
- Liquid waste in suitable containers that are clean, free of contamination, and have a leak proof cap
- Dry waste that is double bagged in clear 3-mil plastic
- Chemical contaminated sharps (with no infectious or biohazardous contamination) in a rigid sharps container
- Treated infectious waste streams or deactivated biological agents that are mixed with chemical wastes

Wastes that will **not** be accepted at a routine pick-up location include:

- Biohazardous waste (medical waste, infectious materials or biohazardous agents) - dispose of these in S&E 1 biowaste room on the loading dock or Castle building 1201, room 1313.
- Radioactive Wastes - contact your health and safety officer
- Controlled Substances - contact your health and safety officer
- Reactive waste streams without a properly vented cap, or containers that are bulging, fuming or bubbling
- Leaking, overflowing, or contaminated containers, or containers that are compromised
- Bags that have protruding glass or other sharps, or bags that are ripped or punctured
- Wastes that require special handling procedures or have shipping restrictions
- Waste streams in incompatible containers
- Unknowns and expired PFCs without a recharge ID
- Wastes that are improperly labeled (i.e. molecular formulas, one constituent listed when others obviously present).

Information about hazardous waste pick-ups is provided in *Appendix O*. Waste is picked up once per week.

Hazardous Waste Minimization

In order to meet our permit obligations and our sustainability mission, EH&S has developed a Hazardous Waste Minimization Program, in an effort to minimize the costs, health hazards, and environmental impacts associated with the disposal of hazardous waste.

ADMINISTRATIVE CONTROLS

In order to reduce the amount of chemicals that become waste, administrative and operational waste minimization controls can be implemented. Usage of chemicals in the laboratory areas should be reviewed to identify practices which can be modified to reduce the amount of hazardous waste generated.

Purchasing Control:

Check the Surplus inventory on the chemical inventory program before new products are ordered. When ordering chemicals, be aware of any properties that may preclude long term storage, and order only exact volumes to be used. Using suppliers who can provide quick delivery of small quantities can assist with reducing surplus chemical inventory. Consider establishing a centralized purchasing program to monitor chemical purchases and avoid duplicate orders.

Inventory Control: Rotate chemical stock to keep chemicals from becoming outdated. Locate surplus/unused chemicals and attempt to redistribute these to other users, or investigate returning unused chemicals to the vendor.

Operational Controls: Review your experimental protocol to ensure that chemical usage is minimized. Reduce total volumes used in experiments; employ small scale procedures when possible. Instead of wet chemical techniques, use instrumental methods, as these generally require smaller quantities of chemicals. Evaluate the costs and benefits of off-site analytical services. Avoid mixing hazardous and non-hazardous waste streams. Distill and reuse solvents if possible. Spent solvents can also be used for initial cleaning, using fresh solvent only for final rinse. Use less hazardous or non-hazardous substitutes when feasible. Some examples include:

- Specialty detergents can be substituted for sulfuric acid/chromic acid cleaning solutions
- Gel Green and Gel Red are recommended in place of ethidium bromide

DRAIN DISPOSAL

UC does not permit drain disposal of chemical wastes, unless a specific dilution and/or neutralization method for a consistent waste stream has been reviewed and approved by EH&S. This applies to weak acid and base solutions. As indicated in previous sections, EPA hazardous waste definitions specify that materials with a pH between 2.5 and 12.5 are not hazardous wastes. However, drain disposal of these materials is still not permitted, because local industrial waste water discharge requirements have more restrictive pH thresholds. In addition, acid and base neutralization is considered waste treatment, a process that is strictly regulated by the EPA (see “Bench Top Treatment” below). Contact EH&S for specific questions about drain disposal variances.

Drain disposal of properly disinfected infectious or biohazardous liquids is acceptable, if disinfection is conducted as specified by the EH&S Biosafety Program, and the liquids disposed contain no other hazardous constituents.

BENCH TOP TREATMENT

EPA regulations allow some limited bench top treatment of certain chemical waste streams in laboratories provided that specific procedures are followed. Due to the stringent nature of these requirements, any treatment of hazardous waste in labs must be reviewed and approved by EH&S. The EPA requirements for treating hazardous waste in laboratories generally follow the "Prudent Practices in the Laboratory 1995" (p. 160-171), National Research Council procedures, or other peer-reviewed scientific publications. The quantity of waste treated in one batch cannot exceed 5 gallons of liquid or 18 kilograms of solid/semi-solid waste. As treatment may result in residuals which may have to be managed as hazardous waste, all residual hazardous waste must be handled according to UC's Hazardous Waste Program requirements.

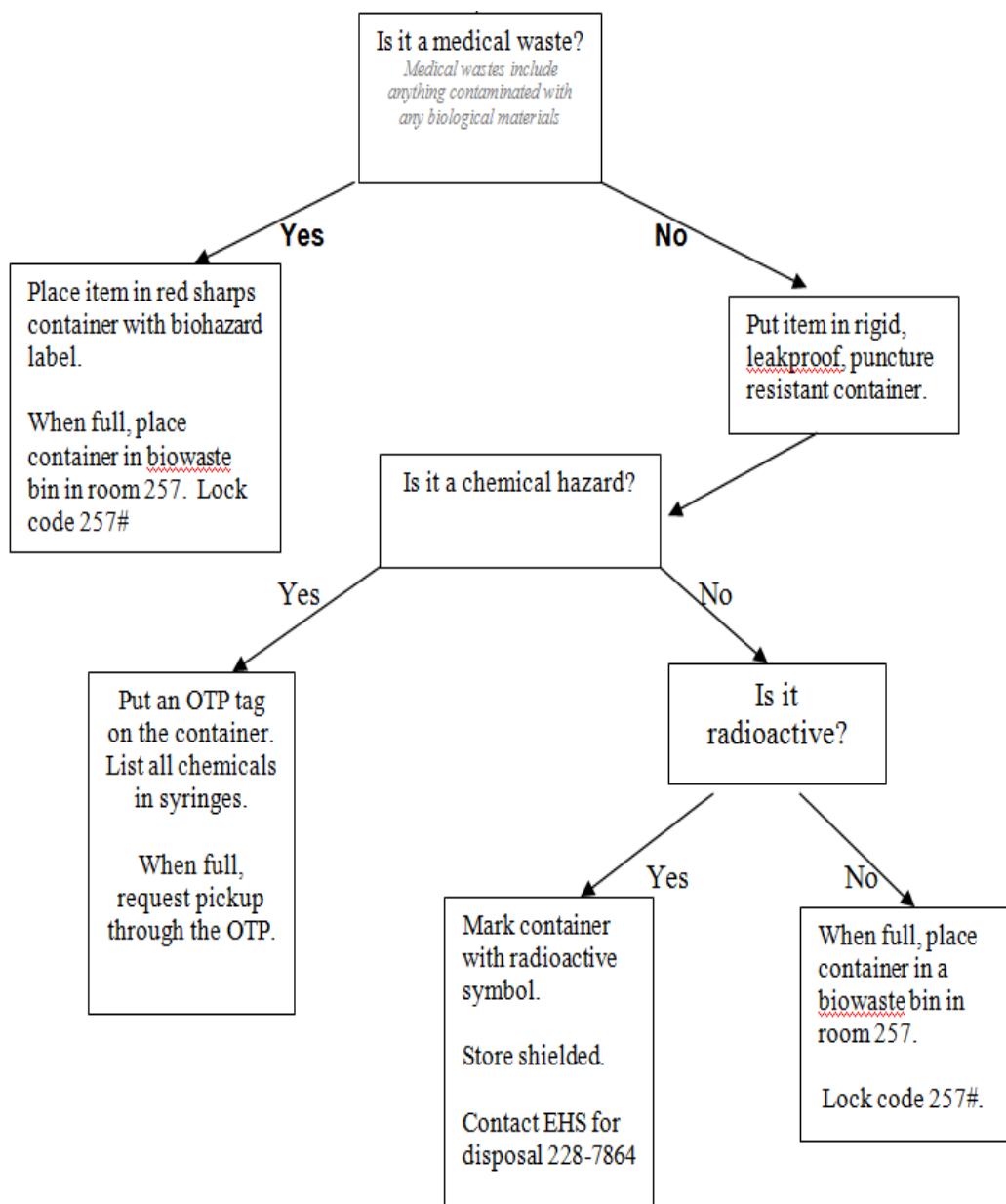
Laboratory specific procedures for hazardous waste should be listed in your LSPS (Section 7, Chemical Safety).

Call EH&S at 228-7864 for further information on chemical and radioactive wastes disposal from your laboratory.

Sharps Decision Tree

Use this guide to help decide how to handle sharps and piercing objects

Sharps and piercing objects can puncture regular waste bags, posing both a physical and a contamination hazard. State and local regulations have become more stringent to protect waste processors, resulting in the increased complexity of treatment, packaging, labeling, and disposal of waste. To make it easy, EH&S has prepared a Sharps and Piercing Objects Decision tree--a flowchart that will guide you to the correct disposal method for your sharps and piercing objects waste. Please note eppendorf tips and serological pipets are considered sharps in addition to broken glass and syringes.



Section 13 – Handling Carcinogens and Reproductive Toxins

This section describes important issues and legal requirements for working with carcinogens.

The surest way to prevent toxic chemicals from causing harm is to minimize exposure. The following sources should be used to help identify and characterize carcinogens and reprotoxins:

- SDS sheets – available from EH&S website
- NTP – National Toxicology Program reports on carcinogens
- IARC – International Agency for Registration of Carcinogens
- ACGIH – American Conference of Governmental Industrial Hygienists
- Prop 65 list – List of carcinogens and reproductive toxins from California Proposition 65
- Chemfinder – Basic information, including carcinogenicity

Information about carcinogens should be used to develop protective measures, including engineering controls, work practices and PPE plus emergency practices and waste management. PPE procedures should include procedures to prevent spread of contamination, including removing any contaminated equipment (such as gloves) before leaving the designated area.

- These measures should be included as separate safety SOPs in the laboratory-specific LSPS (Section 7).
- Maintain an inventory of all carcinogens and reproductive toxins, and all chemicals should be kept in a secure storage area.

A Carcinogen Inventory and List of Storage Areas for all laboratories should be included in Section 13 of the LSPS. You may insert the completed form in appendix E in lieu of filling out section 13

- Storage and work areas where carcinogens are used must be designated with the “Carcinogen” sticker.
- Carcinogens and reproductive toxins should only be used in designated areas that are known to laboratory workers. Access to these areas should be controlled and all work surfaces should be decontaminated after use. Chemical techniques, disposable “bench coat” or other means can be used for decontamination.

Designated Areas and Decontamination Techniques for carcinogen use are listed in the LSPS.

- As with all chemicals, workers have a right to medical attention if they are exposed – see Section 7. Report all exposures immediately for medical evaluation (Section 1).

Carcinogen Reporting

UC Merced is required to make an annual report of use of certain carcinogens. Users of Cal-OSHA Carcinogens must complete a registration form (Appendix E) and return it to EH&S.

Section 14 – Controlled Substances

This section provides information concerning purchasing and using substances listed by the United States Drug Enforcement Agency.

The use of psychotropic drugs, such as narcotics for research purposes, is regulated by the federal government. Narcotics are classified as Schedule I, II, III, IV, V, or as a “Listed Chemical.” Schedule I narcotics have the highest potential for abuse, and no legitimate medical uses. Schedule V narcotics have limited potential for abuse and Listed Chemicals are generally for drug precursors. Lists of controlled substances are available electronically, as well as the Drug Abuse Prevention and Control Act itself.

Laboratories wishing to use controlled substances and listed chemicals for research purposes must fill out a Controlled Substances Use Authorization. These substances can only be used if specifically authorized by the Department Chair, if an appropriate storage location is available in the laboratory, and if an accurate inventory is maintained at all times. Orders must be made through the purchasing department, not by laboratory personnel.

Storage Requirements

Laboratories are required to have a proper drug storage location for controlled substances:

- The cabinet should be equipped with a keyed lock.
- If a padlock is used, the hasp should be installed so that there is no access to the mounting screws or bolts when the door is closed and the lock is fastened.
- Hinges should be installed in such a manner as to prevent access to mounting screws or bolts or to the hinge pins when the door is closed.
- The key should at all times remain in the physical custody of the individual authorized by the Department Chair to maintain a storage cabinet for controlled substances.

Restricted Access

Access to controlled substances must be restricted to specific personnel who will be using these materials. Controlled substances cannot be stored in a cabinet with other, general use chemicals, even if the cabinet locks.

Inventory and Disposal

Laboratories must maintain an accurate inventory of all controlled substances and listed chemicals; forms can be requested from EH&S. Contact EH&S at 228-7864 for instructions on how to dispose of controlled substances.

The controlled substances policy, inventory forms, and use authorization request forms can be found at <http://ehs.ucmerced.edu/node/69>

Section 15 - Hazardous Drug Guidelines

This section contains information about using cytotoxic drugs.

Hazardous Drugs (HDs) include: antineoplastic agents; drugs for which the manufacturer suggests the use of special isolation techniques; drugs known or suspected to be human or animal mutagens, carcinogens, teratogens or reproductive toxicants; (drugs known to be mutagenic in multiple bacterial systems or animals should also be considered hazardous); drugs known to be acutely toxic to an organ system; and Investigational New Drugs.

Damage from many of these agents may be cumulative and related to dose and duration of exposure; therefore, it is essential to use good work practices and proper controls.

1. Appropriate personal protective equipment, including gloves and protective clothing should be worn – see Section 10. A biosafety cabinet (BSC) or chemical fume hood should be used when working with these chemicals – see Section 9.
2. Restrict hazardous drug use to specific areas. All areas where hazardous drugs are stored, prepared or administered should be clearly labeled. In addition, any BSCs used for HD work should be labeled.
3. HD work areas should be covered with disposable plastic-backed bench liner, appropriately labeled sharps containers should be available, and written decontamination/spill control procedures should be posted - see Section 11.
4. Generation of aerosols should be minimized, large bore needles should be used, and as many operations as possible should be conducted in a BSC or chemical fume hood.
5. Materials and equipment in contact with HDs should be labeled, and all waste associated with hazardous drug use should be handled as hazardous waste according to UC Merced procedures, including sharps.
6. All personnel working with hazardous drugs, including technicians, animal handlers, etc. should be informed of the hazards of these materials and the measures necessary to protect themselves. In cases where significant exposures are likely, such as the handling of a large number of treated animals, a program of medical surveillance should be discussed with EH&S.

Procedures for HDs should be included into written laboratory procedures or as separate written “Standard Operating Procedures” or SOPs in Section 7 of your laboratory-specific LSPS.

Issues to be addressed include:

- A description of the procedure and chemicals involved
- Personal Protective Equipment (PPE) – Section 10
- Waste disposal procedures – Section 12
- Any approvals necessary, specific decontamination procedures or any specific designated areas.
- Engineering controls – Section 9
- Spill and emergency procedures – Section 11

Section 16 – Acutely Hazardous Materials

This section contains information about using acutely hazardous materials.

All substances can be toxic, depending on the dose. Special consideration should be given to work with materials that are toxic at very low doses. The table below gives an idea of how to view materials, depending on different measures of toxicity. As with all materials, the basic chemical safety guidelines in Section 7 should be followed and the laboratory should develop an SOP or write the procedure directly into the appropriate LSPS. For acutely hazardous materials special consideration should be given to the establishment of a “Designated Area,” containment devices such as hoods and glove boxes, and decontamination procedures. All waste should be handled according to UC Merced procedures outlined in Section 12.

Toxicity Levels, adapted from Prudent Practices in the Laboratory, 1995

Toxicity Rating	Oral LD ₅₀ – Rat	Skin LD ₅₀ – Rabbit	Inhalation LC ₅₀ – 1 hr, Rat	Inhalation LC ₅₀ – 1 hr, Rat
Highly Toxic	<50 mg/kg	<200 mg/kg	<200 ppm	<2,000 mg/m ³
Moderately Toxic	50 – 500 mg/kg	200 mg – 1 g/kg	200 – 2,000 ppm	2,000 – 20,000 mg/m ³
Slightly Toxic	500mg – 5 g/kg	1 – 5 g/kg	2,000 – 20,000 ppm	20,000 – 200,000 mg/m ³

There are also State and Federal lists of materials considered extremely hazardous. Section 3 of Prudent Practices also has a great deal of useful information for evaluating potential hazards.

Use information from hazard assessment resources to develop safe work practices. These should include engineering controls, such as fume hoods, glove boxes or biosafety cabinets; and personal protective equipment, such as protective clothing, gloves and eye protection. All procedures should be included in written laboratory procedures or as separate safety SOPs.

Guidelines for work with substances of high acute toxicity should include:

- Prior approval or training before beginning work
- Specific areas where work should be performed.
- Storage and labeling practices, including secondary containment.
- Use of engineering controls such as a fume hood or a glove box. As a general rule, materials with a TLV of less than 50 ppm should be used in a hood
- How to respond to small spills and how to evacuate in case of large ones
- How to handle wastes

Section 17 - Select Agents

This section contains information about the use of “Select Agents” as identified by the Center for Disease Control.

The threat of illegitimate use of some toxic and infectious agents has attracted increasing interest. In view of these concerns, the “Anti-Terrorism and Effective Death Penalty Act of 1996” (42 CFR Part 72) established new provisions to regulate the transfer of select agents.

Approval to Work with Select Agents

Individual researchers who wish to use these agents, including botulinum toxin, tetrodotoxin, certain other toxins as well as some hazardous biological agents, must be approved by the EH&S office. These researchers will be asked to document:

1. The individual agents and the type of work being done
2. Where the work will be done, including floor plans showing relevant equipment (fume hoods, biosafety cabinets, incubators, etc.).
3. Safety procedures appropriate for work with acutely hazardous materials, including access control, training and proficiency evaluation along with completed Laboratory Safety Plan Supplement and LSP Training Sheets
4. Agent disposal requirements

The Principal Investigator is responsible for filling out a select agent registration package in order to procure any one of the select agents. Registration forms are available through EH&S.

Purchasing and Sending Select Agents

Please contact the Purchasing Department to place any orders.

Section 18 – Compressed and Hazardous Gases

This section includes guidance for the safe use of compressed gases. Basic requirements apply to all gases; more stringent precautions are needed for toxic gases.

Compressed gases are classified as Class I, II, III or IV, in order of decreasing hazard. **The requirements below apply to all gases.** Additional requirements for hazardous gases (Class I, II and III) are listed on the Hazardous Gas Requirements sheet.

A list of compressed gases used in your laboratory should be included in Section 18 of the LSPS.

For all gas cylinders:

- Store cylinders in an upright position and in a well-ventilated area. Cap when not in use.
- Secure cylinders with upper and lower restraints, separate from incompatible gas classes (Oxygen must be separated from flammables by 20').

Laboratory cylinders less than 18" tall may be secured by stands or wall brackets.

- Do not store cylinders in exits or egress routes.
- Cylinders and gas lines must be labeled. Do not depend on color codes.
- Do not roll, drag, slide containers, or lift cylinders by cylinder caps. Instead, use a hand truck or other suitable device.
- Always transport cylinders with cylinder caps in place.
- Do not attempt to repair a cylinder, valve or regulator.
- If a cylinder leak cannot be stopped by tightening the valve gland or packing nut, close the leaking valve, replace the valve cap and move the cylinder to a well-ventilated area (i.e., outdoors). Notify EH&S (228-7864 or 9-911) as soon as possible.
- Always use the correct regulator and never use adapters.
- Cylinders of flammable gases, such as oxy-acetylene torch units, should have flashback protectors installed.

Compressed gas cylinders can corrode or degrade over time and should be returned to the manufacturer if they are no longer being used. This will remove any potential hazard and save the demurrage charge, which can exceed the cost of the gas over time.

Do not use lecture bottles if other cylinders are available. Lecture bottles are very difficult to dispose of and they use universal threads and valves (some of which are interchangeable). If lecture bottles are used, label all associated equipment with the gas name to prevent unintentional mixing of incompatible materials.

Hazardous Gas Requirements

Gases are classified as Class I, Class II, Class III or Class IV based on LC₅₀ (rat)

(LC₅₀ (rat) = lethal concentration for 50% of test rats)

- **Class I** – LC₅₀ (rat) < 200 ppm
- **Class II** – 201 ppm < LC₅₀ (rat) < 3000 ppm
- **Class III** – 3001 < LC₅₀ (rat) < 5000 ppm
- **Class IV** – LC₅₀ (rat) > 5001 ppm

Requirements	Class IV	Laboratory Exempt	Class III	Class II	Class I
Basic Gas Safety Requirements	X	X	X	X	X
Exhausted Enclosures (gas cabinets or hoods)		X	X	X	X
Discharge Treatment to ½ IDLH at release		X	X	X	X
Leak Check Procedures for cylinders and manifolds		X	X	X	X
E/R Plan, Team and drills		X	X	X	X
Restrictive Orifice or Flow Limiting device		X	X	X	X
Used in Sprinklered Spaces		X	X	X	X
Documented Annual Maintenance			X	X	X
Compatible Piping			X	X	X
UFC 79-3 (NFPA 704) and No Smoking Signs			X	X	X
Purge Systems			X	X	X
Detector Systems		X (Class 1)		X	X
Emergency Alarms (and explanatory signs)		X (Class 1)		X	X
Welded Connections				X	X
Local Shut-Off				X	X
Excess Flow Triggered Shut-Off				X	X
Seismic Shut-Off				X	X
Emergency Power (alarm, detector, vent)		X (Class 1)		X	X
Monitored secondary containment					X
Auto shutoff (manual or detector triggered)					X
Emergency Control Station					X
Exhaust Flow Alarm		X (Class 1)			X

Section 1.01 Requirements are relaxed for small quantity, short term usage:

Class II and III gases, < 340 SCF (standard cubic feet), used for less than 30 consecutive days require:

- Leak check procedures for cylinders and manifolds.
- Cylinders must have a restrictive orifice, must be in an exhausted enclosure, and must be used in a sprinklered space. No lecture bottles.

Class I, < 20 SCF, used for less than 30 consecutive days require above items, plus

- Gas and exhaust system flow detector systems, connected to an alarm system (not the building fire alarm system).
- Emergency power for detectors and alarms

Requirements may be relaxed for quantities less than 2 pounds, no single cylinder > 1 pound (1/4 pound for Class 1).

Quantities over threshold levels raise the level of classification.

Section 19 – Cryogenic Liquids

This section provides guidance for working with cryogenic liquids.

Cryogenic liquids, liquefied gases with temperatures below -73° C , and their boil-off vapors rapidly freeze human tissue and cause embrittlement of many common materials. Cryogenic liquids also produce large volumes of gas when they vaporize (at ratios of 600:1 to 1440:1, gas: liquid) and may create oxygen-deficient conditions.

Precautions for working with cryogenic liquids:

- Use appropriate personal protective equipment (PPE) including insulated gloves and eye protection (face shield) during any transfer of cryogenic liquid.
- Minimize boiling and splashing of cryogenic fluid during transfers to open cryogenic containers, such as dewars.
- Avoid clothing that can trap spilled liquid. If skin contact with a cryogenic liquid occurs, do not rub skin. Instead, place the affected part of the body in a warm (not hot) water bath.
- Be alert for the condensation of oxygen from air.
- Use high quality dewars with protective covers, not standard “thermos” bottles.
- Excessive ice buildup could result in the discharge of excessively cold gas or structural damage to the cryogenic container or surroundings.
- All cryogenic systems (including piping) must be equipped with pressure relief devices that are directed to a safe location.
- Hot air, steam, or hot water should be used to thaw frozen equipment. DO NOT USE water to thaw liquid helium equipment.

Cryogenic liquids used in laboratories should be listed in Section 19 of their LSPS.

Section 20—Operational Hazards

This section provides information on operating certain types of equipment safely.

Many common pieces of laboratory equipment can cause severe accidents or damage if not used properly. Below is a list of the most common pieces of equipment.

- **Centrifuging**
- **Ultra-Sonication**
- **Distillation**
- **Water cooled equipment**
- **Vacuum Pumps and systems**
- **Rotary Evaporator use and trapping**
- **Glassware**
- **Photographic Hazards**

Many laboratory chemicals have severe or unique hazards, such as:**Hydrofluoric Acid (HF)**

- **Picric Acid**
- **Perchloric Acid**
- **Ethidium Bromide**
- **Peroxide forming chemicals**

What else should be added to this list? Please help us improve this guide by sending your comments and suggestions to EH&S or 228-7864.

Section 21 – Biosafety

This section contains information concerning the safe handling of biological materials.

The biosafety program covers work with all organisms (bacteria, chlamydia, fungi, parasites, prions, rickettsias, viruses, etc.), toxins, and allergens that can cause disease in humans, or cause significant environmental or agricultural impact. The program also covers work with human or primate tissues, human or non-human embryonic stem cells, recombinant DNA (rDNA), transgenic plants or animals, human gene therapy, releases of rDNA to the environment, and work with animals known to be reservoirs of zoonotic diseases. Bear in mind that a large number of organisms that would ordinarily be innocuous can be infective in immuno-compromised persons. Please contact the Biosafety Officer at EH&S, (909) 288-4639 to discuss your work if your laboratory currently works with or intends to begin working with biological materials. The Biosafety Officer will assist you in determining whether institutional authorization is required in order to perform this work.



Please use the following guide to assist you:

- Principal Investigators may need an approved *Biological Use Authorization (BUA)* prior to working with biological materials. To apply for a BUA please contact the Biosafety Officer in EH&S.
- It is also important to note that before any one begins working with biologicals, he or she must attend the EH&S *Biosafety or Bloodborne Pathogens Safety* class, depending upon the risk assessment conducted by the Biosafety Officer and/or the Institutional Biosafety Committee (IBC).
- Each Principal Investigator who is authorized to use biological material (either exempt from requiring a BUA or requiring a BUA) is required to follow procedures outlined in the UC Merced Biosafety Manual. This manual is available on the UC Merced EH&S website, on the Biosafety page, and is updated annually, or as regulations change. The Biosafety Manual is written to comply with NIH guidelines, the handbook of “Biosafety in Microbiological and Biomedical Laboratories”, 5th edition, state & federal regulations, and UC-wide best practices.

Manuals and forms are located at: <http://ehs.ucmerced.edu/research-safety/biosafety>

Section 22 – Radiation Safety

This section is intended to provide basic information about UC Merced's Radiation Safety Program. Contact EH&S for more information.

The Radiation Safety Program at UC Merced is designed to protect researchers when working with ionizing radiation and radiation producing machines. For any questions regarding radioactive materials (RAM) or devices capable of producing ionizing or non-ionizing radiation (e.g. x-ray machines, lasers, etc.) contact EH&S.



Please use the following guide to assist you:

- Principal Investigators need a *Radioisotope Use Authorization* (RUA) prior to working with RAM or radiation producing machines. To apply for an RUA please contact EH&S.
- Use the *Radioisotope User Enrollment Form* to add an employee to an RUA before he or she begins to work with ionizing radiation. Obtain a copy of the form from EH&S.
- It is also important to note that before any one begins working with ionizing radiation, he or she must attend the EH&S *Radiation Safety* class.
- For laboratory relocations, decommissioning or clearances, contact EH&S at 228-7864.
- Each Principal Investigator who is authorized to use radioactive material will be assigned a copy of the UC Merced Radiation Safety Manual at the time an application for an RUA is approved. This should be kept in the main facility where radioactive materials or radiation-producing machines are used. All persons using radioactive materials or ionizing-radiation-producing devices are required to be familiar with, and comply with, all provisions of this publication. For any further inquiries contact EH&S.

Manuals and forms are located at <http://ehs.ucmerced.edu/research-safety/radiation-safety>

Section 23 – Physical Hazards

Explosions

When there is a reasonable risk that a reaction or system could explode, blast shields will be used and projects must be approved by EHS or the chemical safety committee. This includes use of tube furnaces, pressure reactors, and energetic materials.

Crushing

Equipment will be left in a zero mechanical state. Equipment should be guarded to prevent persons from entering crush zones.

Pinching

Equipment with pinch or nip points will be guarded to prevent access to the operator's hands.

Pressure and Vacuum systems – including regulators, dewars, manifolds, and pressure reactors.

Goggles or safety glasses will be used at all times.

Damaged pressure systems will be removed from service immediately.

Safety relief valves will not be defeated.

Blast shields will be used or glassware / pressure vessels taped, coated with plastic, or wrapped in plastic mesh.

Manifold systems will be designed for the intended operating pressures.

Braided metal, copper or stainless steel tubing are recommended for plumbing gases under pressure. Do not use flexible hose such as tygon or latex tubing.

Important UC Merced Safety Telephone Numbers

Useful telephone numbers for UC Merced researchers. Always 9-911 in an emergency

Department	Contact	Office Phone	Cell Phone
OFFICE OF ENVIRONMENTAL HEALTH & SAFETY	David Ott	228-4234	
	Karen Smith	228-7864	205-8176
	Monica Lurtz	228-4639	756-2937
	Gini Krippner	228-4473	
FACILITIES MANAGEMENT	HELP DESK	228-2986	
	Mark Lutz	228-7819	217-7251

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Appendix A: General Rules for Laboratory Work with Chemicals

PRUDENT LABORATORY PRACTICES

It is prudent to minimize all chemical exposures. Few laboratory chemicals are without hazards, and general precautions for handling all laboratory chemicals should be adopted, in addition to specific guidelines for particular chemicals. Exposure should be minimized even for substances of no known significant hazard, and special precautions should be taken for work with substances that present special hazards. One should assume that any mixture will be more toxic than its most toxic component and that all substances of unknown toxicity are toxic.

Avoid inadvertent exposures to hazardous chemicals by developing and encouraging safe habits and thereby promoting a strong safety culture.

Safe Laboratory Habits

Personal Protective Equipment:

- Wear closed-toe shoes and full length pants, or equivalent, at all times when in the laboratory
- Utilize appropriate PPE while in the laboratory and while performing procedures that involve the use of hazardous chemicals or materials. These items may include laboratory coats, gloves, and safety glasses or goggles. (See UC PPE Policy in *Appendix R*)
- Confine long hair and loose clothing
- Wear appropriate gloves when the potential for contact with toxic materials exists; inspect the gloves before each use, and replace them often
- Remove laboratory coats or gloves immediately on significant contamination, as well as before leaving the laboratory
- Avoid use of contact lenses in the laboratory unless necessary; if they are used, inform supervisor so special precautions can be taken
- Ensure that appropriate PPE is worn by all persons, including visitors, where chemicals are stored or handled
- Use appropriate respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls, inspecting the respirator before use. Use of respirators requires successful completion of the EH&S Respirator Training and Fit Test course. Use any other protective and emergency apparel and equipment as appropriate. Be aware of the locations of first aid kits and emergency eyewash and shower stations

Chemical Handling:

- Use only those chemicals for which the quality of the available ventilation system is appropriate
- Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices
- Properly label and store all chemicals. Use secondary containment at all times
- Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan
- In the case of an accident or spill, refer to the emergency response procedures for the specific material. These procedures should be readily available to all personnel. Information on minor chemical spill mitigation may also be referenced in *Appendix P*. For general guidance, the following situations should be addressed:

- Eye Contact: Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention
- Skin Contact: Promptly flush the affected area with water and remove any contaminated clothing. If symptoms persist after washing, seek medical attention
- Clean-up: Promptly clean up spills, using appropriate protective apparel and equipment, and proper disposal

Equipment Storage and Handling:

- Use equipment only for its designed purpose
- Store laboratory glassware with care to avoid damage. Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur
- Use certified fume hoods, glove boxes, or other ventilation devices for operations which might result in release of toxic chemical vapors or dust. Preventing the escape of these types of materials into the working atmosphere is one of the best ways to prevent exposure
- Keep hood closed at all times, except when adjustments within the hood are being made
- Leave the fume hood "on" even when it is not in active use if toxic substances are in the fume hood or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is "off"

- **Laboratory Operations:** Keep the work area clean and uncluttered
- Seek information and advice about hazards, plan appropriate protective procedures, and plan positioning of equipment before beginning any new operation
- If unattended operations are unavoidable, and have been approved by the PI/Laboratory Supervisor, place an appropriate sign on the door, leave lights on, and provide for containment of toxic substances in the event of failure of a utility service (such as cooling water)
- Be alert to unsafe conditions and ensure that they are corrected when detected

UNSAFE LABORATORY HABITS

Personal Protective Equipment:

- Do not enter the laboratory without wearing appropriate clothing, including closed-toe shoes and full length pants, or equivalent. The area of skin between the shoe and ankle should not be exposed. (See UC PPE Policy in appendix R)
- Do not wear laboratory coats or gloves outside of the laboratory area

Chemical Handling:

- Do not smell or taste chemicals.
- Do not allow release of toxic substances or fumes into cold or warm rooms, as these types of areas typically involve re-circulated atmospheres
- Never use mouth suction for pipeting or starting a siphon
- Do not dispose of any hazardous chemicals through the sewer system. These substances might interfere with the biological activity of waste water treatment plants, create fire or explosion hazards, cause structural damage or obstruct flow

Equipment Storage and Handling:

- Do not use damaged glassware or other equipment, under any circumstances. The use of damaged glassware increases the risks of implosion, explosion, spills, and other accidents
- Do not use uncertified fume hoods or glove boxes for hazardous chemical handling
- Avoid storing materials in hoods and do not allow them to block vents or air flow

Laboratory Operations:

- Never work alone on procedures involving hazardous chemicals, biological agents, or other physical hazards
- Avoid unattended operations, if at all possible. Unattended operations require prior approval from the PI/Laboratory Supervisor
- Do not engage in distracting behavior such as practical joke playing in the laboratory. This type of conduct may confuse, startle, or distract another worker

Food/Drink:

- Do not eat, drink, smoke, chew gum, or apply cosmetics in areas where laboratory chemicals are present; wash hands before conducting these activities
- Do not store, handle, or consume food or beverages in storage areas, or use refrigerators, glassware or utensils which are also used for laboratory operations
- Wash areas of exposed skin well before leaving the laboratory.

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Appendix B: Sample Safety Data Sheet (SDS)

 ScienceLab.com Chemicals & Laboratory Equipment	 Health 3 Fire 2 Reactivity 0 Personal Protection G											
Material Safety Data Sheet Formaldehyde 37% solution MSDS												
Section 1: Chemical Product and Company Identification												
Product Name: Formaldehyde 37% solution	Contact Information: Scienclab.com, Inc. 14025 Smith Rd. Houston, Texas 77396 US Sales: 1-800-901-7247 International Sales: 1-281-441-4400 Order Online: ScienceLab.com											
Catalog Codes: SLF1426												
CAS#: Mixture.												
RTECS: LP8925000												
TSCA: TSCA 8(b) inventory: Formaldehyde; Methyl alcohol; Water												
CI#: Not applicable.	CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300											
Synonym: Formalin	International CHEMTREC, call: 1-703-527-3887											
Chemical Name: Formaldehyde	For non-emergency assistance, call: 1-281-441-4400											
Chemical Formula: HCHO												
Section 2: Composition and Information on Ingredients												
Composition:												
<table border="1"><thead><tr><th>Name</th><th>CAS #</th><th>% by Weight</th></tr></thead><tbody><tr><td>Formaldehyde</td><td>50-00-0</td><td>36.5-38</td></tr><tr><td>Methyl alcohol</td><td>67-56-1</td><td>10-15</td></tr><tr><td>Water</td><td>7732-18-5</td><td>47-53.5</td></tr></tbody></table>	Name	CAS #	% by Weight	Formaldehyde	50-00-0	36.5-38	Methyl alcohol	67-56-1	10-15	Water	7732-18-5	47-53.5
Name	CAS #	% by Weight										
Formaldehyde	50-00-0	36.5-38										
Methyl alcohol	67-56-1	10-15										
Water	7732-18-5	47-53.5										
Toxicological Data on Ingredients: Formaldehyde: ORAL (LD50): Acute: 100 mg/kg [Rat]. 42 mg/kg [Mouse]. 280 mg/kg [Guinea pig]. MIST (LC50): Acute: 454000 mg/m ³ 4 hours [Mouse]. Methyl alcohol: ORAL (LD50): Acute: 5628 mg/kg [Rat]. DERMAL (LD50): Acute: 15800 mg/kg [Rabbit]. VAPOR (LC50): Acute: 64000 ppm 4 hours [Rat].												
Section 3: Hazards Identification												
Potential Acute Health Effects: Very hazardous in case of eye contact (irritant), of ingestion, . Hazardous in case of skin contact (irritant, sensitizer, permeator), of eye contact (corrosive). Slightly hazardous in case of skin contact (corrosive). Severe over-exposure can result in death. Inflammation of the eye is characterized by redness, watering, and itching.												
Potential Chronic Health Effects: Hazardous in case of skin contact (sensitizer). CARCINOGENIC EFFECTS: Classified A2 (Suspected for human.) by ACGIH, 2A (Probable for human.) by IARC [Formaldehyde]. MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. [Formaldehyde]. Mutagenic for bacteria and/or yeast. [Formaldehyde]. Mutagenic for mammalian somatic cells. [Methyl]												

Sample SDS, cont.

alcohol]. Mutagenic for bacteria and/or yeast. [Methyl alcohol]. TERATOGENIC EFFECTS: Classified POSSIBLE for human [Methyl alcohol]. DEVELOPMENTAL TOXICITY: Not available The substance may be toxic to kidneys, liver, skin, central nervous system (CNS). Repeated or prolonged exposure to the substance can produce target organs damage. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Section 4: First Aid Measures

Eye Contact:

Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Get medical attention immediately.

Skin Contact:

In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact:

Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation:

Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:

If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Flammable.

Auto-Ignition Temperature: 430°C (806°F)

Flash Points: CLOSED CUP: 50°C (122°F). OPEN CUP: 60°C (140°F).

Flammable Limits: The greatest known range is LOWER: 6% UPPER: 36.5% (Methyl alcohol)

Products of Combustion: These products are carbon oxides (CO, CO₂).

Fire Hazards in Presence of Various Substances:

Flammable in presence of open flames and sparks, of heat. Non-flammable in presence of shocks, of oxidizing materials, of reducing materials, of combustible materials, of organic materials, of metals, of acids, of alkalis.

Explosion Hazards in Presence of Various Substances: Non-explosive in presence of open flames and sparks, of shocks.

Fire Fighting Media and Instructions:

Flammable liquid, soluble or dispersed in water. SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use alcohol foam, water spray or fog. Cool containing vessels with water jet in order to prevent pressure build-up, autoignition or explosion.

Special Remarks on Fire Hazards:

Explosive in the form of vapor when exposed to heat or flame. Vapor may travel considerable distance to source of ignition and flash back. When heated to decomposition, it emits acrid smoke and irritating fumes. CAUTION: MAY BURN WITH NEAR INVISIBLE FLAME (Methyl alcohol)

Sample SDS, cont.

Special Remarks on Explosion Hazards:

Reaction with peroxide, nitrogen dioxide, and permformic acid can cause an explosion. (Formaldehyde gas)

Section 6: Accidental Release Measures

Small Spill:

Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: Neutralize the residue with a dilute solution of sodium carbonate.

Large Spill:

Flammable liquid. Poisonous liquid. Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of sodium carbonate. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:

Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, reducing agents, acids, alkalis, moisture.

Storage:

Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame).

Section 8: Exposure Controls/Personal Protection

Engineering Controls:

Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:

Safety glasses. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves (impervious).

Personal Protection in Case of a Large Spill:

Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:

Formaldehyde gas STEL: 0.3 (ppm) from ACGIH (TLV) [United States] STEL: 0.37 (mg/m³) from ACGIH (TLV) [United States] TWA: 0.75 STEL: 2 (ppm) from OSHA (PEL) [United States] TWA: 2 STEL: 2 (ppm) [United Kingdom (UK)] TWA: 2.5 STEL: 2.5 (mg/m³) [United Kingdom (UK)] Methyl alcohol TWA: 200 from OSHA (PEL) [United States] TWA: 200 STEL: 250 (ppm) from ACGIH (TLV) [United States] [1999] STEL: 250 from NIOSH [United States] TWA: 200 STEL: 250 (ppm) from NIOSH SKIN TWA: 200 STEL: 250 (ppm) [Canada] Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

Odor: Pungent. Suffocating. (Strong.)

Taste: Not available.

Sample SDS, cont.

Molecular Weight: 30.02

Color: Clear Colorless.

pH (1% soln/water): 3 [Acidic.] pH of the solution as is.

Boiling Point: 98°C (208.4°F)

Melting Point: -15°C (5°F)

Critical Temperature: The lowest known value is 240°C (484°F) (Methyl alcohol).

Specific Gravity: 1.08 (Water = 1)

Vapor Pressure: 2.4 kPa (@ 20°C)

Vapor Density: 1.03 (Air = 1)

Volatility: 100% (w/w).

Odor Threshold: The highest known value is 100 ppm (Methyl alcohol)

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Non-ionic.

Dispersion Properties: See solubility in water, diethyl ether, acetone.

Solubility:

Easily soluble in cold water, hot water. Soluble in diethyl ether, acetone, alcohol

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Heat, ignition sources (flames, sparks), incompatible materials

Incompatibility with various substances:

Reactive with oxidizing agents, reducing agents, acids, alkalis. Slightly reactive to reactive with metals.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity:

Also incompatible with urea, phenol, isocyanates, anhydrides, amines, AZO compounds, carbonyl compounds, oxides(e.g. nitrogen dioxide), performic acid, dithiocarbamates, or peroxides. Polymerization can be inhibited by the addition of methanol or stabilizers such as hydroxypropyl methyl cellulose, methyl ethyl celluloses, or isophthalobisguanamine.

Special Remarks on Corrosivity: Not available.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation.

Toxicity to Animals:

Acute oral toxicity (LD50): 42 mg/kg [Mouse]. (Formaldehyde) Acute dermal toxicity (LD50): 15800 mg/kg [Rabbit]. (Methyl alcohol). Acute toxicity of the mist(LC50): 454000 mg/m³ 4 hours [Mouse]. (Formaldehyde) 3

Chronic Effects on Humans:

CARCINOGENIC EFFECTS: Classified A2 (Suspected for human.) by ACGIH, 2A (Probable for human.) by IARC [Formaldehyde].

MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. [Formaldehyde]. Mutagenic for bacteria and/or yeast. [Formaldehyde]. Mutagenic for mammalian somatic cells. [Methyl alcohol]. Mutagenic for bacteria and/or yeast. [Methyl alcohol].

TERATOGENIC EFFECTS: Classified POSSIBLE for human [Methyl alcohol].

DEVELOPMENTAL TOXICITY: Not available May cause damage to the following organs: kidneys, liver, central nervous system (CNS).

Sample SDS, cont.

Other Toxic Effects on Humans:

Very hazardous in case of ingestion, . Hazardous in case of skin contact (irritant, sensitizer, permeator), of eye contact (corrosive), of inhalation (lung corrosive). Slightly hazardous in case of skin contact (corrosive).

Special Remarks on Toxicity to Animals:

Formaldehyde: LD50 [Rabbit] - Route: Skin; Dose: 270 ul/kg

Special Remarks on Chronic Effects on Humans:

Exposure to Formaldehyde and Methanol may affect genetic material (mutagenic). Exposure to Formaldehyde and Methanol may cause adverse reproductive effects and birth defects(teratogenic). Adverse reproductive effects of Formaldehyde as well as Methanol are primarily based on animal studies. Very few human studies have been done on the adverse reproductive effects from exposure to Formaldehyde. Studies produced a weak association (limited evidence) between adverse human female reproductive effects and occupational exposure. Furthermore, no human data could be found on adverse reproductive effects from occupational exposure to Methanol. Exposure to Formaldehyde may cause cancer.

Special Remarks on other Toxic Effects on Humans:

Acute Potential Health Effects: Skin: Corrosive. Causes skin irritation which may range from mild to severe with possible burns depending on the extent of exposure and concentration of solution. Other symptoms may include brownish discoloration of the skin, urticaria, and pustulovesicular eruptions. May be absorbed through skin with symptoms paralleling those of ingestion. Eyes: Corrosive. Contact with liquid causes severe eye irritation and burns. It may cause irreversible eye damage (severe corneal Solutions containing low formaldehyde concentrations may produce transient discomfort and irritation. Inhalation: Causes irritation of the respiratory tract (nose, throat, airways). Symptoms may include dry and sore mouth and throat, thirst, and sleep disturbances, difficulty breathing, shortness of breath, coughing, sneezing, wheezing rhinitis, chest tightness, pulmonary edema, bronchitis, tracheitis, laryngospasm, pneumonia, palpitations. It may also affect metabolism weight loss, metabolic acidosis), behavior/central nervous system (excitement, central nervous system depression, somnolence, convulsions, stupor, aggression, headache, weakness, dizziness, drowsiness, coma), peripheral nervous system, and blood. Ingestion: Harmful if swallowed. May be fatal. Causes gastrointestinal irritation with nausea, vomiting (possibly with blood), diarrhea, severe pain in mouth, throat and stomach, and possible corrosive injury to the gastrointestinal mucosa/ulceration or bleeding from stomach. May also affect the liver(jaundice), urinary system/kidneys (difficulty urinating, albuminuria, hematuria, anuria), blood, endocrine system, respiration (respiratory obstruction, pulmonary edema, bronchiolar obstruction), cardiovascular system (hypotension), metabolism (metabolic acidosis), eyes (retinal changes, visual field changes), and behavior/central nervous system (symptoms similar to those for inhalation). Contains Methanol which may cause blindness if swallowed. Chronic Potential Health Effects: Skin: Prolonged or repeated exposure may cause contact dermatitis both irritant and allergic. It may also cause skin discoloration. Inhalation: Although there is no clear evidence, prolonged or repeated exposure may induce allergic asthma. Other effects are similar to that of acute exposure. Ingestion: Prolonged or repeated ingestion may cause gastrointestinal tract irritation and ulceration or bleeding from the stomach. Other effects may be similar to that of acute ingestion.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD₅ and COD: Not available.

Products of Biodegradation:

Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation:

Methanol in water is rapidly biodegraded and volatilized. Aquatic hydrolysis, oxidation, photolysis, adsorption to sediment, and bioconcentration are not significant fate processes. The half-life of methanol in surfact water ranges from 24 hrs. to 168 hrs. Based on its vapor pressure, methanol exists almost entirely in the vapor phase in the ambient atmosphere. It is degraded by reaction with photochemically produced hydroxyl radicals and has an estimated half-life of 17.8 days. Methanol is physically removed from air by rain due to its solubility. Methanol can react with NO₂ in polluted to form methyl nitrate. The half-life of methanol in air ranges from 71 hrs. (3 days) to 713 hrs. (29.7 days) based on photooxidation half-life in air. (Methyl alcohol)

Section 13: Disposal Considerations

Sample SDS, cont.

Waste Disposal:

Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification:

CLASS 3: Flammable liquid. Class 8: Corrosive material

Identification: : Formaldehyde Solution, flammable (Methyl alcohol) UNNA: 1198 PG: III

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:

California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer, birth defects or other reproductive harm, which would require a warning under the statute: Formaldehyde California prop. 65 (no significant risk level): Formaldehyde: 0.04 mg/day (inhalation) California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer which would require a warning under the statute: Formaldehyde Solution Connecticut hazardous material survey.: Formaldehyde; Methyl alcohol Illinois toxic substances disclosure to employee act: Formaldehyde; Methyl alcohol Illinois chemical safety act: Formaldehyde; Methyl alcohol New York release reporting list: Formaldehyde; Methyl alcohol Rhode Island RTK hazardous substances: Formaldehyde; Methyl alcohol Pennsylvania RTK: Formaldehyde; Methyl alcohol Minnesota: Formaldehyde gas; Methyl alcohol Massachusetts RTK: Formaldehyde; Methyl alcohol Massachusetts spill list: Formaldehyde; Methyl alcohol New Jersey: Formaldehyde; Methyl alcohol New Jersey spill list: Formaldehyde; Methyl alcohol Louisiana RTK reporting list: Formaldehyde Louisiana spill reporting: Formaldehyde; Methyl alcohol California Director's List of Hazardous Substances: Formaldehyde; Methyl alcohol TSCA 8(b) inventory: Formaldehyde gas; Methyl alcohol; Water TSCA 4(f) priority risk review: Formaldehyde, Reagt, ACS SARA 302/304/311/312 extremely hazardous substances: Formaldehyde SARA 313 toxic chemical notification and release reporting: Formaldehyde; Methyl alcohol CERCLA: Hazardous substances.: Formaldehyde: 100 lbs. (45.36 kg); Methyl alcohol: 5000 lbs. (2268 kg);

Other Regulations:

OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada):

CLASS B-3: Combustible liquid with a flash point between 37.8°C (100°F) and 93.3°C (200°F). CLASS D-1A: Material causing immediate and serious toxic effects (VERY TOXIC). CLASS D-2A: Material causing other toxic effects (VERY TOXIC).

DSCL (EEC):

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 2

Reactivity: 0

Personal Protection: G

National Fire Protection Association (U.S.A.):

Health: 3

Flammability: 2

Reactivity: 0

Specific hazard:

Sample SDS, cont.

Protective Equipment:

Gloves (impervious). Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Safety glasses.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

Created: 10/09/2005 05:35 PM

Last Updated: 11/01/2010 12:00 PM

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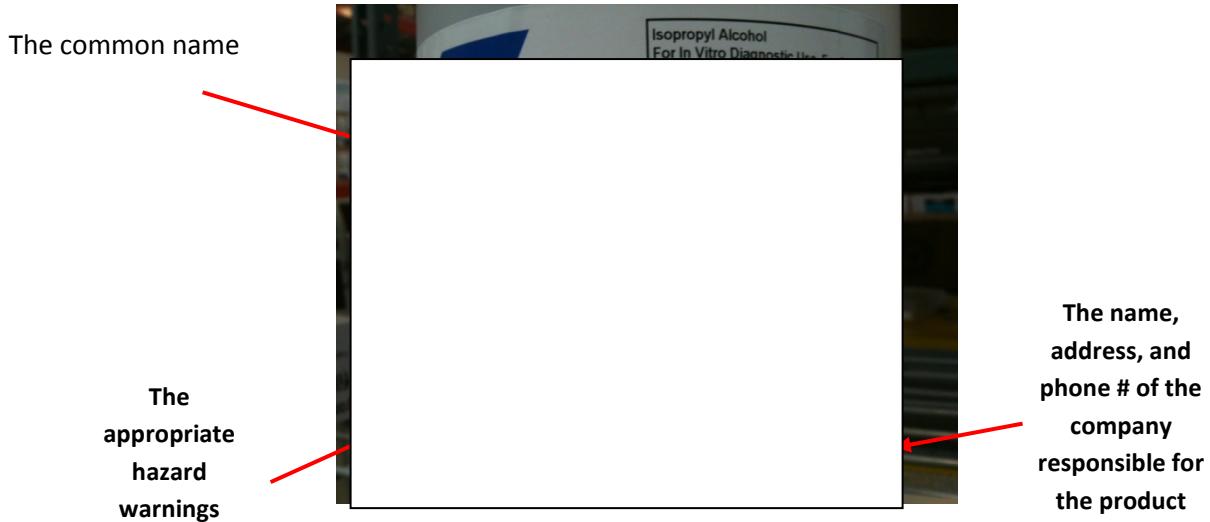
Obtain SDS from the online UC SDS library: <http://www.ucmsds.com/?X>.

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Appendix C: Container Labeling

Chemical container labels are a good resource for information on chemical hazards. All containers of hazardous chemicals must have labels attached. Figure C.1 displays the label requirements.

Figure C.1. – Container Labeling Requirements



The warning may be a single word (e.g. Danger, Caution, Warning) or may identify the primary hazards, including both physical (e.g. water reactive, flammable, or explosive) and health (e.g. carcinogen, corrosive or irritant), such as what is found on an NFPA diamond, GHS pictograms and hazard warnings from the label or SDS.

GHS – Hazard Pictograms and correlated exemplary Hazard Classes				
Physical Hazards				
Explosives	Flammable Liquids	Oxidizing Liquids	Compressed Gases	Corrosive to Metals
Health Hazards				
Acute Toxicity	Skin Corrosion	Skin Irritation	CMR ¹ , STOT ² , Aspiration Hazard	Hazardous to the Aquatic Environment

1) carcinogenic, germ cell mutagenic, toxic to reproduction / 2) specific target organ toxicity

Most labels provide additional safety information to help workers protect themselves from the substance. This information may include protective measures and/or protective clothing to be used, first aid instructions, storage information and emergency procedures.

Chemical Labeling – What are Laboratory Personnel Responsible for?

- Inspecting incoming containers to be sure that labels are attached and are in good condition and contain the information outlined above
- Reading the container label each time a newly purchased chemical is used. It is possible that the manufacturer may have added new hazard information or reformulated the product since the last purchase
- Ensuring that chemical container labels are not removed or defaced, except when containers are empty
- Labeling any secondary containers used in the laboratory, to prevent unknown chemicals or inadvertent reaction
- Verifying that chemical waste containers have complete and accurate chemical waste labels

Labeling is important for the safe management of chemicals, preventing accidental misuse, inadvertent mixing of incompatible chemicals, and facilitating proper chemical storage. Proper labeling helps ensure quick response in the event of an accident, such as a chemical spill or chemical exposure incident. Finally, proper labeling prevents the high costs associated with disposal of “unknown” chemicals.

With the exception of transient containers that will contain chemicals for immediate use, all containers of chemicals being used or generated in UC research laboratories must be labeled sufficiently to indicate the contents of the container. On original containers, the label must not be removed or defaced in any way until the container is emptied of its original contents. Incoming containers must be inspected to make sure the label is in good condition. It is also advisable to put a date on new chemicals when they are received in the laboratory, and to put a date on containers of chemicals generated in the laboratory, as well as the initials of the responsible person.

Abbreviations or other acronyms may be used to label containers of chemicals generated in the laboratory as long as all personnel working in the laboratory understand the meaning of the label, or know the location of information, such as a laboratory notebook or log sheet that contains the code associated with content information. In addition, small containers, such as vials and test tubes, can be labeled as a group by labeling the outer container (e.g., rack or box). Alternatively, a placard can be used to label the storage location for small containers (e.g., shelf, refrigerator, etc.). This information must be provided to janitorial and maintenance staff as part of their hazard communication training.

Containers of practically non-toxic and relatively harmless chemicals must also be labeled with content information, including containers such as squirt bottles containing water.

With respect to chemical labeling, all potentially hazardous chemicals transferred from their original container to a second container must be labeled with the chemical name and the principal hazards found on the primary container label or SDS. For more information on labeling, see Chapter 6: Labeling, Storage, Inventory and Transport.

Appendix D: SOP Instructions and Template

INSTRUCTIONS FOR COMPLETING STANDARD OPERATING PROCEDURES

To be in compliance with the Cal/OSHA Laboratory Standard, laboratory-specific Standard Operating Procedures (SOPs) are required to be included in your Laboratory Safety Plan. This manual does not provide specific SOPs for the hazardous chemical or hazardous substance use operations or procedures in your particular laboratory. If your laboratory research involves the use of hazardous substances or chemicals, you must develop laboratory-specific SOPs to supplement the information found in the Laboratory Safety Plan. You may work with your departmental safety committee and EH&S, as required. Below are instructions for completing the laboratory-specific SOPs with the corresponding template. Please contact your designated Laboratory Safety Officer with any questions or comments you may have while completing your SOPs. Completed SOPs are reviewed by the Laboratory Safety Officer during annual inspections. Chemical specific SOP templates are available at <http://ehs.ucmerced.edu/node/75> and ehs.ucop.edu/radical. Radical will complete all safety information, PIs just need to add procedures.

1. Type of SOP

- **Process:** the SOP will be for a process such as distillation, synthesis, etc.
- **Hazardous chemical:** the SOP will be for an individual chemical such as arsenic, formaldehyde, nitric acid, etc.
- **Hazard class:** the SOP will be for a hazard class of chemicals such as oxidizer, flammable, corrosive, etc.

2. Describe the Process, Hazardous Chemical or Hazard Class

- **Process:** Briefly describe the process and name all the hazardous chemicals or substances used in the process
- **Hazardous chemical:** Provide the name of the chemical. Include the full name, common name, and any abbreviations used for the chemical
- **Hazard class:** Name the hazard class and list the name of the chemicals in this hazard class used or stored in your laboratory

3. Potential Hazards

Describe all the potential hazards for each process, hazardous chemical, or hazard class. Describe the potential for both physical and health hazards. Health hazards include carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes. State the potential for chronic and/or acute health hazard effects of the chemical(s).

Physical hazards include radioactivity, cryogen, high temperature, electrical, compressed gas or other pressure systems, UV light, laser, flammable or combustible, corrosive, water-reactive, unstable, oxidizer, pyrophoric, explosive, or peroxide formers.

4. Circumstances Requiring Prior Approval

Discuss the circumstances under which this particular process, hazardous chemical or hazard class will require prior approval (if any) from the PI/Laboratory Supervisor or Chemical Hygiene Officer. The circumstances may be based on such criteria as: the inherent hazards of the material(s) used, the hazards of the experimental

process, the experience level of the worker, the scale of the reaction, etc. Some examples of circumstances that may require prior approval include unattended or overnight operations, use of explosives or pyrophorics, use of highly toxic gas in any amount, use of large quantities of toxic or corrosive gases or use of carcinogens.

5. Personal Protective Equipment (PPE)

Identify the required PPE for the process, hazardous chemical, or hazard class. PPE includes, but is not limited to: gloves, aprons, laboratory coats, safety glasses, goggles, masks, respirators, or face shields.

6. Engineering Controls

Describe or list engineering controls that will be used to prevent or reduce employee exposure to hazards. Examples of engineering controls are fume hoods, glove boxes, interlocks on equipment, and shielding of various kinds.

7. Special Handling and Storage Requirements

Describe the storage requirements for hazardous substances, including special containment devices, special temperature requirements, special storage areas or cabinets, chemical compatibility storage requirements, etc. State the policy regarding access to the substance(s). Provide the exact storage location in the laboratory. Describe any special procedures, such as dating peroxide forming chemicals on receipt, opening and disposal, or testing after an appropriate amount of time has passed. Describe safe methods of transport, such as in a secondary container using a low, stable cart, or using two hands to carry the chemical container.

8. Spill and Accident Procedures

Describe special procedures for spills, releases or exposures (e.g., neutralizing agents, use of fluorescence to detect materials, etc.). Indicate how spills, accidental releases and exposures will be handled. List location of the following emergency equipment: chemical spill clean-up kit, first-aid kit, emergency shower, eyewash, and fire extinguisher.

9. Decontamination Procedures

Describe specific decontamination procedures for equipment, glassware or work areas.

10. Waste Disposal Procedures

Describe the anticipated waste products as well as how waste will be collected and disposed.

11. Designated Area

Indicate the designated area established for experiments using particularly hazardous substances (PHS). A portion of a laboratory bench, a piece of equipment, the fume hood, or the entire laboratory may be considered as a designated area for experiments using PHS.

12. Safety Data Sheet (SDS) Location

State where the SDSs are kept for the chemicals, or hazardous substances, used in the laboratory. Indicate the location of other pertinent safety information (e.g., references, equipment manuals, etc.).

13. Protocols

Insert a copy of your specific laboratory procedures for the process, hazardous chemical or hazard class. Include the maximum acceptable quantities or concentrations to be used if specific quantities cannot be listed.

14. Risk assessment

Low – very small quantities of materials at low concentrations with no to little chance of harming the worker.

Medium – Materials may be heated, are medium concentration (i.e. 6M HCl). Failure to use PPE could result in injury.

High- failure to follow procedures will lead to severe, permanent injury or death. Materials are under high pressure, react vigorously, are of high concentration, very toxic, pyrophoric.

15. Signatures

The PI and document reviewer must sign the cover page. Any students using the material must sign the back page. (If Radical is used, all signatures are completed electronically).

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Appendix E: UC Particularly Hazardous Substances Policy

*These are UC Merced procedures based on UCLA Policy #907, but have not been formerly adopted as an official UCM policy.

UCM Policy ___:	Safe Handling of Particularly Hazardous Substances
Issuing Officer:	Vice Chancellor for Research
Responsible Dept:	Environment, Health & Safety
Effective Date:	
Supersedes:	

I.	REFERENCES
II.	PURPOSE
III.	STATEMENT
IV.	RESPONSIBILITIES
V.	LABORATORY SAFETY REQUIREMENTS &
VI.	PROCEDURES ATTACHMENTS

I. REFERENCES

1. Title 8, California Code of Regulations (CCR), Section 5191 (Occupational Exposures to Hazardous Chemicals in Laboratories; Article 110 (Regulated Carcinogens); Section 5209 (Listed Carcinogens); Section 5203 (Report of Use Requirements); Section 5154.1 (Ventilation Requirements for Laboratory-Type Hood Operations);
2. UC Policy 905, Research Laboratory Personal Safety and Protective Equipment;

II. PURPOSE

This Policy provides general guidance on how to work safely with chemicals that have been designated as "particularly hazardous" by Cal/OSHA. It describes the minimum requirements for the safe storage, use, handling, and disposal of particularly hazardous substances, including spill and accident response procedures. Particularly hazardous substances are defined by Cal/OSHA as: reproductive toxins, acutely toxic substances and select carcinogens, which include regulated carcinogens. Refer to Attachment A, Particularly Hazardous Substances Definitions, for specific definitions.

III. STATEMENT

This Policy is applicable to, and must be adhered to by, all UC laboratory workers (i.e., Principal Investigators, laboratory personnel, students, visiting researchers, etc.) who use or work with particularly hazardous substances. Careful handling and stringent controls of these chemicals are essential to protect workers and the environment, and to comply with Cal/OSHA regulations.

Additional safety requirements may apply, depending on the specific chemical. For example, carcinogens that are also highly flammable require both particularly hazardous substance controls as well as fire safety controls. Contact your health and safety officer for guidance on use of chemicals that may require further controls. Information and guidance on handling of particularly hazardous substances can also be found in UC's Chemical Hygiene Plan.

IV. RESPONSIBILITIES

Preventing workplace injuries, exposures, and illnesses is the responsibility of every member of the campus community. Specific responsibilities are assigned to more senior members of the research and teaching community in order to implement, and ensure compliance with this Policy by their subordinate personnel.

The Chancellor has overall responsibility for compliance with health and safety requirements at all facilities and programs under campus control.

The Vice Chancellor for Research is responsible for the implementation of this Policy in all applicable research and teaching laboratories within his or her jurisdiction.

The UC Laboratory Safety Committee (LSC) has a broad oversight role in overseeing research activities and is responsible for promoting a safe working environment in all research and teaching laboratories on campus, and for developing, updating and maintaining policies applicable to the health and safety of laboratory work.

Department Chairpersons are responsible for communicating, promoting and enforcing this Policy in their respective research and teaching areas.

Principal Investigators and laboratory management staff are responsible for complying with this Policy and ensuring their laboratory personnel receive appropriate training and comply with this Policy as it relates to their research and teaching activities.

All Laboratory Personnel working in laboratory areas are responsible for following laboratory safety requirements, including how to work safely with substances designated as particularly hazardous.

The UC Office of Environment, Health & Safety (EH&S) is responsible for inspection of laboratories and for campus compliance with this Policy. In cases where laboratory activities pose an immediate danger to life or health, designated EH&S staff have the responsibility and authority to order the temporary cessation of the activity until the hazardous condition is abated.

The UC Chemical Hygiene Officer (CHO), also referred to as the Chemical Safety Officer, is responsible for facilitating necessary reviews of procedures that involve the use of hazardous chemicals. The reviews of procedures should primarily be provided by subject experts as part of a departmental safety committee. The CHO, with the support of other EH&S Research Safety Experts, will support, and assist in the organization of, and provide annual oversight for this process.

V. LABORATORY SAFETY REQUIREMENTS & PROCEDURES

A. Laboratory Specific Standard Operating Procedures

1. Individual laboratory groups must prepare and maintain laboratory-specific standard operating procedures (SOP) for identifying hazards and handling methods to avoid exposure to particularly hazardous substances. The procedures must indicate the designated use areas, limitations on the quantities and procedures used, information on containments, and information on hazards involved. These procedures may be specific to particular substances or generalized over a group of chemicals with similar hazardous properties and use limitations. Chemical-specific procedures must be developed for each Cal/OSHA regulated carcinogen and procedures should be

developed for reproductive toxins, acutely toxic materials, and select carcinogens. EH&S can provide additional guidance for specific chemical hazards.

2. A copy of the particularly hazardous substances procedures, including laboratory specific information, and the Safety data sheets (SDS) for the chemical(s) used must be readily accessible in the lab.
3. EH&S must be notified immediately if members of the laboratory become ill or exhibit signs or symptoms associated with exposure to hazardous chemicals used in the laboratory. Affected employees must be provided immediate first aid and medical surveillance within 24-hours of the event.
4. Principal Investigators must identify what classes of particularly hazardous substances are in use in their labs on their PPE Assessment Tool which must be completed as conditions change in the laboratory,

B. Training and Documentation

1. All laboratory personnel who work with or may be exposed to particularly hazardous substances must be provided laboratory-specific training and information by the Principal Investigator or their designee prior to beginning their initial assignment. Laboratory-specific training should cover specific policies and procedures, etc. and is in addition to the basics covered in the Laboratory Safety Fundamentals training. Records of laboratory-specific training must be maintained in the laboratory and should include an outline of the topics covered. A form is available at the end of the Laboratory Safety Plan Supplement (LSPS) Training shall include:
 - The hazards/toxicological effects associated with the chemicals being used.
 - Routine procedures and decontamination methods.
 - Emergency response practices and procedures.
 - Methods and observations for detecting the presence or release of hazardous chemicals.
 - Available protection measures, including appropriate work practices and personal protective equipment (PPE).
 - A review of written SOP and SDSs and the Chemical Hygiene Plan (CHP).
 - A review of this Policy.
2. All laboratory personnel are responsible for knowing and complying with all safety guidelines, regulations, and procedures required for the task assigned and for reporting unsafe conditions, accidents or near misses to the Principal Investigator, immediate laboratory management staff or EH&S.
3. Continuing training shall be conducted as needed to maintain a working knowledge of hazards and the safety requirements for all laboratory personnel who work with particularly hazardous substances, including an annual refresher for particularly hazardous substances. Written records must be maintained for each training session. See <http://ehs.ucla.edu/LabTrainingRecord.pdf> for a sample documentation form.

C. Use in Designated Areas

1. Designated area(s) for use of particularly hazardous substances must be formally established by developing SOPs and posting appropriate signage. This designated area(s) may be an entire laboratory, a specific work bench, or a chemical fume hood. When particularly hazardous substances are in use, access to the designated area shall be limited to personnel following appropriate procedures and who are trained in working with these chemicals.
2. Access to areas where particularly hazardous substances are used or stored must be controlled by trained employees. Working quantities of particularly hazardous substances should be kept as

small as practical and their use should be physically contained as much as possible, usually within a laboratory fume hood or glove box. It is the responsibility of each Principal Investigator, or their designee, to train and authorize their staff for these operations and to maintain documentation of this training and authorization.

3. Signage is required for all containers, designated work areas and storage locations. Sign wording must state the following as appropriate for the specific chemical hazard:

“DANGER, CANCER HAZARD – SUSPECT AGENT”

“DANGER, CANCER HAZARD – REGULATED CARCINOGEN”

“DANGER, REPRODUCTIVE TOXIN”

“DANGER, ACUTE TOXIN”

Entrances to designated work areas and storage locations must include signage, “AUTHORIZED PERSONNEL ONLY”, in addition to the above specific hazard warning wording.

4. Work surfaces should be stainless steel, plastic trays, dry absorbent plastic backed paper, chemically resistant epoxy surfaces, or other chemically impervious material.
5. Protocols, procedures, and experiments must be designed and performed in a manner to safely maintain control of the particularly hazardous substances. Laboratory personnel must specifically consult with their Principal Investigators if a special hazard is involved (e.g., material under pressure) or if they are uncertain of the potential hazards.

D. Personal Protective Equipment (PPE)

1. PPE must be sufficient to protect eyes and skin from contact with the hazardous agents. At minimum, safety glasses, lab coat, long pants, closed toe shoes, and gloves are required when working with particularly hazardous substances. See UC Policy 905, Research Laboratory Personal Safety and Protective Equipment for more information. Goggles may be required for processes in which a splash or spray hazard may exist and flame resistant lab coats may be required if the chemicals being used are flammable.
2. Refer to the specific chemical's SDS and SOP for specific information on additional PPE and glove selection.
3. Contaminated PPE and clothing must be disposed of or decontaminated prior to removal from the designated work area. While small spots of contamination may be cleaned in the lab, grossly contaminated lab coats may need to be disposed of as dry hazardous waste. Refer to UC Policy 905 and the Chemical Hygiene Plan for guidance on handling contaminated protective apparel and other PPE.

E. Engineering Controls

1. Bench top work with particularly hazardous substances should be avoided whenever practical in favor of contained systems (such as fume hoods or glove boxes) and is not permitted if there is a reasonable likelihood of workers exceeding regulatory exposure limits. For questions regarding exposure limits and for assistance in conducting a hazard assessment for uncontained procedures, contact your health and safety officer.
2. Laboratories and rooms where particularly hazardous substances are used outside of containment systems must have general room ventilation that is maintained at negative pressure with respect to public areas. Air from these ventilation systems must be vented externally; recirculation is not permitted. Doors providing access from public areas must be kept closed.

F. Special Handling & Storage Requirements

1. Particularly hazardous substances must be stored in a designated area and used in a manner that will minimize the risk of accidental release (e.g., capped tightly, use of chemical resistant Chemical Hygiene Plan

secondary containment, whenever possible). Laboratory personnel should remove chemicals from storage only as needed and return them to storage as soon as practical.

2. Chemicals should be segregated from incompatible materials, as described in the UC Chemical Hygiene Plan. The use of particularly hazardous substances must be confined to an established designated area (see C. Use in Designated Areas, above).
3. Additional requirements for the safe storage of a specific chemical may be found in the manufacturer's instructions or in the SDS.
4. When transporting chemicals beyond the immediate laboratory environment, containers should be protected from breakage by using a bottle carrier or other effective containment.
5. Contact your health and safety officer. for guidance on the planned use of chemicals that may require further controls.

G. Spill & Accident Procedures

1. Immediate measures must be available to prevent the possible spread of contamination in the event of a small spill of a particularly hazardous substance. Absorbent materials and clean up materials should be available in all laboratories sufficient to contain and decontaminate individuals and equipment and areas. Any known spills must be contained and decontaminated as soon as possible.
2. In the event of a large spill that is beyond a laboratory group's immediate response capabilities, the following procedures should be followed:
 - a. Evacuate the area immediately.
 - b. Restrict access to the affected areas to emergency responders and post signage and barriers as needed to prevent unauthorized entry.
 - c. Contact EH&S Hazmat immediately for response and remediation. Call 9-911 from a UC campus phone or 911 from a cell phone (to UCPD) as needed.
3. In the event of direct skin contact with a particularly hazardous substance, the affected person must shower or flush the affected areas for a minimum of 15 minutes. Whenever personal contamination occurs, the event must be reported to your health and safety officer and an incident report will be completed and maintained by EH&S.
4. If the spill involves acutely toxic materials, the spill should be treated as a large spill if there is any doubt about the group's ability to safely mitigate the spill.
5. If the spill involves regulated carcinogens, a Report of Use may need to be filed (see J. Regulated Carcinogens and Report of Use Requirements, below).

H. Routine Decontamination Procedures

1. To limit the spread of contamination, laboratory work surfaces should be decontaminated at the conclusion of each procedure and at the end of each day on which particularly hazardous substances are used.
2. All equipment should be decontaminated before removing it from the designated area; this decontamination should be carried out in a glove box or fume hood where practical.
3. Contaminated PPE must not be removed from the designated area until properly decontaminated; refer to the PPE policy (appendix R) and the Lab Safety Plan for guidance on the cleaning of protective apparel and other PPE. After working with these chemicals, gloves must immediately be removed and disposed of as hazardous waste and hands and arms washed with soap and water.

I. Waste Disposal Procedures

1. Disposal of waste materials that include particularly hazardous substances must comply with the hazardous chemical waste disposal procedures found in the Laboratory Safety Manual.

2. In addition to general hazardous waste labeling requirements, waste containers containing particularly hazardous substances must also be labeled as appropriate for the specific chemical hazard:
 - “DANGER, CANCER HAZARD – SUSPECT AGENT”
 - “DANGER, CANCER HAZARD – REGULATED CARCINOGEN”
 - “DANGER, REPRODUCTIVE TOXIN”
 - “DANGER, ACUTE TOXIN”
3. All non-radioactive chemical waste must be disposed of through the UC Hazardous Chemical Waste Program. Mixed wastes of hazardous chemicals and radioactive material are disposed of through the Radiation Safety Department. Due to regulatory restrictions and the high cost of disposal, the Radiation Safety Department should be contacted prior to producing mixed wastes.

J. Regulated Carcinogens and Report of Use Requirements

1. Regulated carcinogens are a specific subset of select carcinogens which have special additional requirements associated with their use under certain circumstances. See Attachment B for the specific list. EH&S maintains an air sampling program to monitor individuals to determine if they are, or may reasonably be expected to, exceed short or long term exposure limits. Every effort should be made to keep exposure levels below these limits by using fume hoods, limiting the quantities used, and following SOP designed to reduce exposure. If levels cannot be kept below these levels, additional requirements may include:
 - Required medical evaluations.
 - Additional documented training.
 - Use of respirators with required initial and ongoing training, medical evaluations, and maintenance documentation.
 - Additional documented hazard evaluations.
2. Listed carcinogens are a further subset of regulated carcinogens. See Attachment C for the specific list. The use of these materials must be registered with EH&S through the PPE Assessment Tool or other equivalent EH&S approved process. An evaluation will be completed to assess safety requirements for groups that use these materials.

Report of Use Requirements must be met for each group when they:

- Begin the use of, or make significant changes to existing use of any listed carcinogen.
- Use regulated carcinogens such that there is a reasonable expectation that exposure limits may be exceeded.
- In the event of an emergency in which employees have been exposed to any regulated carcinogen.

VI. ATTACHMENTS

- A. Particularly Hazardous Substances Definitions
- B. Regulated Carcinogens
- C. Listed Carcinogens

Issuing Officer

Vice Chancellor for Research

**Questions concerning this policy or procedure should be referred to
the Responsible Department listed at the top of this document.**

ATTACHMENT A

Particularly Hazardous Substances Definitions

Particularly hazardous substances fall into the following three major categories: acute toxins, reproductive toxins, and carcinogens. Acute Toxins

Substances that have a high degree of acute toxicity are substances that may be fatal or cause damage to target organs as the result of a single exposure or exposures of short duration. They can be defined as:

1. A chemical with a median lethal dose (LD50) of 50 mg or less per kg of body weight when administered orally to albino rats weighing between 200 and 300 gm. each;
2. A chemical with a median lethal dose (LD50) of 200 mg or less per kg of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 Kg each; and
3. A chemical that has a median lethal concentration (LC50) in air of 5000 ppm by volume or less of gas or vapor, or 50 mg per liter or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 gm. each.

Reproductive Toxins

Reproductive toxins include any chemical that may affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis). A list of reproductive toxins is maintained online at http://www.oehha.ca.gov/prop65/prop65_list/Newlist.html#files.

Carcinogens

Carcinogens are chemical or physical agents that cause cancer. Generally, they are chronically toxic substances; that is, they cause damage after repeated or long-duration exposure, and their effects may only become evident after a long latency period.

The term “regulated carcinogen” means a recognized cancer causing substance, compound, mixture, or product regulated by Cal/OSHA sections 1529, 1532, 1532.2, 1535, 8358, 8359 or Article 110, sections 5200-5220. See *Attachment B for the specific list of Regulated Carcinogens*.

The term “Listed Carcinogen” refers to a specific list of 13 chemicals regulated by Cal/OSHA and Federal OSHA and has specific use and handling requirements. See *Attachment C for the specific list of Listed Carcinogens*.

The term “select carcinogen” refers to a category of chemicals where the available evidence strongly indicates that the substances cause human carcinogenicity. A select carcinogen meets one of the following criteria:

1. It is regulated by Cal/OSHA as a carcinogen; or
2. It is listed under the category “known to be carcinogens” in the annual report by the National Toxicology Program (NTP); or
3. It is listed under Group 1 – “carcinogenic to humans” – by the International Agency for Research on Cancer (IARC); or
4. It is listed in either Group 2A or Group 2B by the IARC or under the category “reasonably anticipated to be carcinogens” by the 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/m³;
 - 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.

A T T A C H M E N T B
Regulated Carcinogens

The term “regulated carcinogen” means a recognized cancer causing substance, compound, mixture, or product regulated by Cal/OSHA sections 1529, 1532, 1532.2, 1535, 8358, 8359 or Article 110, sections 5200-5220. For more information, see UC Policy 907.

- Acrylonitrile
- Arsenic metal and inorganic arsenic compounds
- Asbestos
- Benzene
- 1,3-butadiene
- Cadmium metal and cadmium compounds
- Chromium(VI) compounds
- Coke Oven Emissions
- 1,2-Dibromo-3-chloropropane (DBCP)
- Ethylene Dibromide (EDB)
- Ethylene Oxide (EtO)
- Formaldehyde gas and formaldehyde solutions
- Lead metal and inorganic lead compounds
- Methylene Chloride
- 4,4'-Methylene bis(2-chloroaniline) (MBOCA)
- Methylenedianiline (MDA)
- Vinyl Chloride
- 2-Acetylaminofluorene
- 4-Aminodiphenyl
- Benzidine (and its salts)
- 3,3'-Dichlorobenzidine (and its salts)
- 4-Dimethylaminoazobenzene
- alpha-Naphthylamine
- beta-Naphthylamine
- 4-Nitrobiphenyl
- N-Nitrosodimethylamine
- beta-Propiolactone
- bis-Chloromethyl ether
- Methyl chloromethyl ether
- Ethyleneimine

ATTACHMENT C

Listed Carcinogens

The term “listed carcinogen” refers to a specific list of 13 chemicals regulated by Cal/OSHA and Federal OSHA and has specific use and handling requirements. For more information, see UC Policy 907.

- 2-Acetylaminofluorene
- 4-Aminodiphenyl
- Benzidine (and its salts)
- 3,3'-Dichlorobenzidine (and its salts)
- 4-Dimethylaminoazobenzene
- alpha-Naphthylamine
- beta-Naphthylamine
- 4-Nitrobiphenyl
- N-Nitrosodimethylamine
- beta-Propiolactone
- bis-Chloromethyl ether
- Methyl chloromethyl ether
- Ethyleneimine

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Before using any particularly hazardous substance (PHS), please complete this form and have it approved by the Principal Investigator, and EH&S. See p.4 for more complete definitions of a PHS and instructions for completing this form. The SDS will generally list the information needed to determine whether a chemical meets the PHS definition. If you have any questions, contact EH&S for assistance.

Applicant Name _____

Supervisor _____

Division: _____ Bldg. /Office # _____

Phone: _____ Date: _____

Substance Information

A. Chemical name _____ CAS number _____ Physical State _____

B. Carcinogen Reproductive Toxin High Acute Toxicity (circle all that apply)

C. Estimated Rate of Use (e.g., grams/month) _____ Maximum Quantity to be kept on hand _____

D. SDS reviewed and readily available Yes No

E. Duration of Project _____

2. Additional Hazards Associated with this PHS (circle all that apply)

Physical Hazards

A. Flammable Yes No B. Corrosive Yes No

C. Reactive Yes No D. Temperature sensitive Yes No

E. Stability (e.g., decomposes, forms peroxides, polymerizes, shelf-life concerns) Stable Unstable

F. Known incompatibilities _____

Health Hazards

G. Significant Route(s) of Exposure

Inhalation Hazard Yes No

Skin Absorption Yes No

H. Sensitizer Yes No

I. Medical Consultation Needed Yes No

² See (http://safety.dri.edu/LabSafety/PARTICULARLY_HAZARDOUS_SUBSTANCES.pdf) for a partial list of PHSs

Procedure

A. Briefly describe how the material will be used and list all personnel who will be involved in the use of this chemical

B. Vacuum system used Yes No

If yes, describe method for trapping effluents _____

Exposure Controls (circle all that apply)

A. Ventilation/Isolation

1. Hood required? Yes No (*See hood sticker for the following information*)

If yes, hood currently operates at 95 - 125 feet per minute face velocity? Yes No

Hood ID _____

2. Glove box required? Yes No

3. Vented gas cabinet required? Yes No

B. Personal Protective Equipment (PPE) Required (*circle all applicable*)

Safety glasses Chemical splash goggles Face shield

Gloves (type _____) Lab coat Apron

Respirator (*Respirators require EH&S approval*)

Other, please describe _____

Location of Proposed Use/Designated Area

A. Building(s)/Room(s) _____

B. Describe below the area where substance(s) will be used and the method of posting as a designated area.

C. Location where substances will be stored _____

D. Storage Method/Precautions (circle all that apply)

refrigerator/freezer hood

double containment vented cabinet

flammable liquid storage cabinet other, describe _____

Spills and Decontamination

- A. Spill control materials readily available Yes No
B. Special personal protective equipment needed Yes No Describe _____
C. Decontamination method _____

Waste Disposal (circle all that apply)

- A. Bench top neutralization Yes No
B. Deactivation Yes No
C. Dispose as hazardous waste Yes No

8. Authorization

This individual has demonstrated an understanding of the hazards of the listed substance and plans to handle the substance in a manner that minimizes risk to health and property. S/he is authorized to use the substance in the manner described.

Principal Investigator/Supervisor/ Date

Division Chair or Dean/Date

Environmental Health and Safety/Date

A particularly hazardous substance (PHS) includes known or suspected human carcinogens, reproductive toxins, and substances with acute toxicity above certain thresholds.

Each individual planning to use a PHS must complete this form and have it approved by their Principal Investigator (PI) or supervisor, Division Director and EH&S prior to ordering (or if the chemical is already in inventory prior to initial use).

Responsibility for determining whether a chemical is a PHS and completing this form rests jointly with the PI/supervisor and the individual seeking use approval.

Review the substance SDS or other appropriate literature for help in determining whether a substance meets the PHS criteria. Contact EH&S for assistance.

1. Substance Information

- A. Enter name and CAS (Chemical Abstract Service) number and physical state (gas, liquid, solid) for the PHS.
- B. *Carcinogen:* if on IARC, OSHA or NTP list *Reproductive toxin:* mutagens, teratogens, embryotoxins
High Acute Toxicity: oral LD₅₀ ≤ 50 mg/kg, skin LD₅₀ ≤ 200 mg, air LC₅₀ ≤ 200 ppm or ≤ 2 mg/l.
- C. Self-explanatory
- D. SDS may be available in hard copy or via the internet.

2. Hazards Identification

- A. *Flammable liquid:* flashpoint ≤ 100° F.
Flammable solid: likely to cause fire through friction, absorption of moisture, spontaneous chemical change, or which can be ignited readily and when ignited burns vigorously.
- B. *Corrosive:* Causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact.

- C. *Reactive:* May become unstable or contact with water produces flammable or toxic gas.
- D. *Temperature Sensitive:* Must be kept within a certain temperature range to ensure stability.
- E. *Unstable:* substance will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shock, or high or elevated pressure or temperature. Also includes time-sensitive materials, particularly those that produce peroxides over time.
- F. List chemicals or materials that might cause instability or adverse conditions if mixed with the particularly hazardous substance(s).
- G. *Inhalation:* inhalation of the substance may cause adverse health effects. *Skin exposure:* substance is readily absorbed through the skin or can cause significant damage to skin upon contact.
- H. Certain chemicals are known to affect the immune system, causing a person to experience allergic reactions, up to and including anaphylactic shock, upon exposure to the chemical, after the initial sensitization.
- I. Some chemicals can accumulate in body tissues and may require initial or periodic medical surveillance. Contact EH&S for more information.

3. Procedure

- A. Briefly describe the laboratory procedure that involves the substance, with particular attention to how the chemical will be manipulated.
- B. Vacuum systems include central vacuum systems and vacuum pumps within the lab. Describe what will be done to ensure that the substance is not accidentally drawn into the vacuum system. Cold traps or filters are some examples of such measures.

¹ Much of the information required for the form can be found on the chemical's safety data sheet (SDS) or container label

4. Exposure Controls

- A. A chemical hood should be used for chemicals that may produce vapors, mists, or fumes, or if the procedure may cause generation of aerosols.

The hood must have an average face velocity of between 95 and 125 feet per minute. This measurement is noted on the hood survey sticker. If the hood has not been inspected within the past year, contact Facilities via the work request process for re-inspection before using the hood.

The hood number is noted on the bottom of the hood survey sticker.

- B. A glove box should be used if protection from atmospheric moisture or oxygen is needed or when a chemical hood may not provide adequate protection from exposure to the substance; e.g., a protection factor of 10,000 or more is needed.
- C. Highly toxic gases must be used and stored in a vented gas cabinet connected to a laboratory exhaust system. Gas feed lines operating above atmospheric pressure must use coaxial tubing.
- D. **Safety glasses with side shields** protect from flying particles and minor chemical splashes, for instance, from opening a centrifuge tube.

Chemical splash goggles should be worn when there is a possibility of a significant chemical splash. Most chemical manipulations, particularly where pressure is involved, warrant chemical splash goggles.

Face shield, worn with splash goggles, provides full face protection when working with large volumes of chemicals. The use of a face shield is especially important when dispensing corrosive chemicals.

Gloves should be worn when working with any particularly hazardous substance. Since not all gloves offer significant protection from every chemical, it is important to choose the glove that offers the best resistance. See the SDS or glove manufacturer compatibility charts for more information.

Lab coats should be worn when working with hazardous substances. The coat should not be worn outside the laboratory and should be laundered separately from other clothing.

Aprons offer chemical resistance and protection from splashes and can be used in conjunction with a lab coat.

Respirators offer protection from inhalation of substances when engineering controls are not sufficient. Use of respirators must be approved by EH&S. Prior to approving a respirator a medical clearance may be required. Contact EH&S for more information.

5. Location/Designated Area

- A. Building(s) and room number(s) where the substance will be used.
- B. Describe where in the room(s) the substance will be used. For example, in a hood, on a specific bench top, in several areas of the laboratory, etc. This room or area must be posted as a *Designated Use Area*.
- C. Describe where the substance will be stored. Be specific, e.g., on a shelf, in a refrigerator, in a hood, etc.
- D. Self-explanatory. *Double containment* means that the container will be placed inside another container that is capable of holding the contents in the event of a leak and provides a protective outer covering in the event of contamination of the primary container.

6. Spills and Decontamination

A and B. Self-explanatory.

- C. Describe how the work area will be decontaminated after use, in the event of a spill, or upon completion of the work and before removal of the designated area signage.

7. Waste Disposal

- A. Some corrosive chemicals may be bench top neutralized then drain disposed.
- B. Some materials, such as ethidium bromide, can be chemically deactivated before disposal.
- C. See the EH&S web page for more information about the hazardous waste program. No chemicals may be poured down the drain without first consulting EH&S.

Appendix G: Regulated Carcinogens

Cal/OSHA Regulated Carcinogens fall into a higher hazard class and have extensive additional requirements associated with them. The use of these agents may require personal exposure sampling based on usage. The following is the list of Cal/OSHA Regulated Carcinogens.

Cal/OSHA Regulated Carcinogens		
Acrylonitrile	Arsenic (Inorganic)	Ethylene Oxide (EtO)
(MBOCA)	Asbestos	Ethyleneimine
1,2-Dibromo-3-chloropropane (DBCP)	Benzene	Formaldehyde
1,3-butadiene	Benzidine (and its salts)	Lead
2-Acetylaminofluorene	Beta-Naphthylamine	Methyl chloromethyl ether
3,3'-Dichlorobenzidine (and its salts)	Beta-Propiolactone	Methylene Chloride
4,4'-Methylene bis(2-chloroaniline)	Bis-Chloromethyl ether	Methylenedianiline (MDA)
4-Aminodiphenyl	Cadmium	N-Nitrosodimethylamine
4-Dimethylaminoazobenzene	Chromium (VI)	Non Asbestiform Tremolite, Anthophyllite, and Actinolite
4-Nitrobiphenyl	Coke Oven Emissions	Vinyl Chloride
Alpha-Naphthylamine	Ethylene Dibromide (EDB)	

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Appendix H: Respiratory Hazard Assessment Form

This form is designed to assist in the proper selection of respiratory equipment. Complete the information below and review it with your supervisor. Submit completed form via email using the button on the bottom of the form and print a copy for your records. **If a field is not applicable, please enter "N/A."**

First Name: _____ Last Name: _____

Employee ID #: _____ Email: _____

PI Last Name: _____ PI Employee ID #: _____

Department: _____ Building and Room #: _____

The Reason I'm Requesting/Need Respiratory Protection Is: _____

Description of Activity
Requiring A Respirator: _____

Chemical Name: _____ Quantity of Usage: _____

Duration (hrs): _____ Frequency: _____ CAL-OSHA Permissible Exposure Limit: _____

I have reviewed the MSDS for this chemical Yes N/A

Health Hazard
Information: _____

Controls Typically in Place (Check all that apply)

- | | | |
|--|---|---|
| <input type="checkbox"/> Chemical Fume Hood | <input type="checkbox"/> Goggles/Face Shield | <input type="checkbox"/> Benchwork |
| <input type="checkbox"/> Biological Safety Cabinet | <input type="checkbox"/> Lab Coat/Body Protection | <input type="checkbox"/> Clean Room |
| <input type="checkbox"/> Glovebox | <input type="checkbox"/> Gloves | <input type="checkbox"/> Outdoor Activity |

By submitting, I attest that my supervisor/PI has reviewed and
approved this Respiratory Hazard Assessment Form and to the Yes Today's Date
best of my knowledge it is accurate and complete

Obtain this form online at: <http://map.ais.ucla.edu/go/1004655>.

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Appendix I: Peroxide Forming Chemicals (PFCs) Common to Research

Class 1 PFCs

Class 1 chemicals form peroxides after prolonged storage. The chemicals listed below should be tested for the formation of peroxides on a periodic basis. Several methods are available to check for peroxides; the two most common are the use of peroxide test strips or the potassium iodide test.

Class 1 PFCs		
Isopropyl ether	Potassium amide	Vinylidene chloride
Divinyl acetylene	Potassium metal	
Divinyl ether	Sodium amide	

Class 2 PFCs

This group of chemicals will readily form peroxides when they become concentrated (e.g., via evaporation or distillation). The concentration process defeats the action of most auto-oxidation inhibitors. As a result, these chemicals should be disposed of within 12 months of receiving.

Class 2 PFCs		
Acetal	Diethyl ether	Methyl isobutyl ketone
Cumene	Dioxane	Tetrahydrofuran
Cyclohexene	Ethylene glycol dimethyl ether	Tetrahydronaphthalene
Cyclopentene	Furan	Vinyl ethers
Diacetylene	Methylacetylene	
Dicyclopentadiene	Methylcyclopentane	

Class 3 PFCs

This group of chemicals forms peroxides due to initiation of polymerization. When stored in a liquid state, the peroxide forming potential dramatically increases. These chemicals should be disposed of if they become degraded or are no longer needed.

Class 3 PFCs		
Acrylic acid	Chlorotrifluoroethylene	Vinyl acetate
Acrylonitrile	Methyl methacrylate	Vinyl acetylene Vinyl chloride
Butadiene	Styrene	Vinyl pyridine
Chlorobutadiene	Tetrafluoroethylene	Vinylidene chloride

Appendix J: EH&S Safety Training Matrix for Laboratory Personnel

Everyone working in a lab must take the following modules every 3 years:

Laboratory safety fundamentals* (Required before beginning work)

Hazmat spill response

Fire Safety – labs

Exceptions are labs that are strictly computational that are not housed in the same room as labs using chemicals, lasers, or radiation.

Use the guide below to see if other classes are needed.

*= classes available online

Are you UCM faculty, staff , student, or volunteer who...

If yes, take..

Will handle animal carcasses, animal tissue, or will have access to a vivarium?	Medical History Questionnaire and Risk Assessment Form annually, through Occupational Health Facility.
Will have direct contact with <u>live</u> vertebrate animals?	Medical History Questionnaire and Risk Assessment Form annually, through Occupational Health Facility, AND contact IACUC office 228-4613
Is a PI, faculty sponsor, or personnel listed on an approved IACUC protocol, (even if you don't handle animals)?	Contact IACUC office 228-4613
Will use a respirator?	Respirator Training and Fit testing (medical clearance also required) annually through EHS/ OHF
Will use shop equipment?	Shop Safety Training, one time as long as continuously affiliated with UCM. Contact Ed Silva.
Work with nanomaterials?	Nanomaterials every 3 years, through EH&S.
Will work with human or primate materials (blood, specimens, tissue or cells)?	Bloodborne pathogens annually, through EH&S. May need vaccinations. Contact EH&S.
Will use biohazardous materials (including bacteria, viruses, toxins)?	Biosafety every 3 years, through EH&S. May need vaccinations. Contact EH&S.
Will ship materials?	Shipping with Dry Ice* every 3 years through EH&S.
Will handle radioactive materials?	Radiation Safety every 2 years through EH&S.
Will work with lasers?	Laser Safety* every 3 years through EH&S
Will work with x-ray equipment or radiation producing machines?	Radiation Safety every 2 years through Mike Dunlap.
Will perform a survival surgery procedure or a procedure requiring aseptic technique?	Medical History Questionnaire and Risk Assessment Form annually, through Occupational Health Facility.

Will have access to or enter an animal barrier facility?	Medical History Questionnaire and Risk Assessment Form annually, through Occupational Health Facility.
Will enter or have access to an animal biocontainment facility?	Medical History Questionnaire and Risk Assessment Form annually, through Occupational Health Facility.
Will receive hazardous materials?	DOT HazMat Awareness every 3 years through EH&S.
Work with compressed gases?	Compressed Gases every 3 years through EH&S
Work with controlled substances (scheduled drugs) or drug precursors?	Controlled Substances every 3 years through EH&S
Generate chemical waste?	Waste management in the lab every 3 years through EH&S.
Work off site or at field stations?	Field Safety every 3 years through EH&S, and fill out field safety plan.

Appendix K: Employee Training History

For each laboratory employee, use this document to maintain a history of safety training completed. Be sure to include site-specific training, EH&S training and any off-campus training. Refer to the Laboratory Safety Manual and the Safety Training Curriculum for Laboratory Personnel for direction on the required training topics. This documentation is to be maintained in the Laboratory Safety Manual.

Employee Name: _____ Supervisor: _____

Assigned Laboratories: _____

Each laboratory employee must be made aware of the location and content of the *Laboratory Safety Manual*. By your signature below, you acknowledge that you have read and understood the contents of the manual, and know how to access it in the laboratory.

Employee Signature: _____ Date: _____

Title or Description of Training	Provided By:	Date

Obtain this

form on the EH&S website (www.ehs.ucla.edu) under Laboratory Safety.

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Appendix L: Site-Specific Training Record

Use this document to record any site-specific training sessions, and place a copy in the *Laboratory Safety Manual*.

Training Topic: _____

Location: _____ Date: _____ Duration: _____

Name	Signature	UCLA ID#

Last updated on 3/9/09

Obtain this form on the EH&S website (www.ehs.ucla.edu) under Laboratory Safety.

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Appendix M: Laboratory Inspection Checklist

Survey Date:	Lab Contact:
P.I.:	Surveyor(s):
P.I. Phone: Day Night	Date Corrections must be complete 1 week / 6 mos.
Bldg. Name:	Date Corrections ALL complete:
Room #s:	Total Score:

Answer every question by checking "Yes" or "No", circling where appropriate, and noting which rooms where present.

#	<i>Characteristics of Lab/Research</i>	Yes	No	<i>Rooms where applicable</i>
1.	Animals Y N In vivarium space only Y N			
2.	Biohazards (bacteria, virus, fungus, human blood/cell			
3.	Synthetic DNA (ordered or synthesized), plasmids, viral vectors?			
4.	Select agents?			
5.	Controlled Substances?			
6.	Hazardous Chemical (flammables, toxics, corrosives, reactives			
7.	OSHA Carcinogens?			
8.	Gas Cylinders? (H ₂ , O ₂ , N ₂ Liquid, Toxics, others)			
9.	Radioactive Materials/Radiation producing equipment?			
10	Research Lasers? (Class IIIa, IIIb , IV)			
11	Fume hoods? All currently certified? Y N			
12	Biosafety Safety Cabinets/Laminar Flow Hoods? Is UV light used for disinfection?			
13	Respirators, Dust Masks?			
14	Emergency eyewash/showers?			
15	Autoclave/Barrels used for bio-waste?			
16	Machine Shop?			
17	Shipments of dangerous goods, clinical specimens or live organisms?			

18	Does your lab engage in any outside field work?			
19	Other unusual hazards associated with research or lab?			
20	Do you have plastic water-baths? If yes, what brand and			

Past issues: Corrected?

TRAINING

3pt- all lab workers trained and can demonstrate knowledge

2pt- all workers trained but fail to demonstrate knowledge

1pt- some workers not trained

0pt- Less than 50% workers trained

1.	Can lab describe its safety training recordkeeping system?				
2.	Are all staff members currently trained (provided training was available from EHS since beginning work)				Post Information and describe to employee how to access.
3.	Does staff know how to access applicable safety information?				

Comments:

DOCUMENTATION -

3pt- all plans and inventory in place

2pt- One required plan missing or expired.

1pt - Two required plans missing or expired.

0 pt. -More than two required plans missing or expired.

4.	Laboratory Safety Plan				
5.	Laboratory Safety Plan Supplement				
6.	Lab specific training documented? (end of LSPS, back of LSTOM)				
7.	SDS				
8.	Radiation Safety Manual				
9.	Radiation User Agreement				
10.	Laser Safety Manual				
11.	Laser User Registration				
12.	Biological Use Authorization				

13.	UC Merced Biosafety Manual				
14.	Self-inspection record (once per year)				
15.	Chemical inventory				
16.	PPE Assessment tool complete (LHAT)				
17.	Field safety plans filed?				
18.					

Comments:

HAZARD COMMUNICATION

2pt-- appropriate signage, current contact list,

1pt-- missing one or two items

Opt – lack of hazard communication that could lead to injury (i.e. no SOP for high hazard activity)

19.	Is applicable signage present and accurate? Outside door occupant label, on all eyewashes/ showers, PI contact lists, carcinogen report of use				
20.	Emergency Notification Information				Provide & post during survey
21.	Emergency Flip Flipchart				
22.	Hazardous Waste Guidelines Flyer				
23.	Hazard Communication Signs & Labels (Bio, Rad, Chem) on door, equipment, chemical bottles				
24.	SOP's are available.				

Comments:

GENERAL SAFETY –

2pt – well organized, clean, (incl. hoods) emergency equipment not blocked

1pt – housekeeping is adequate

0 pt. –poor housekeeping, ER equipment blocked, hoods cluttered, poor spill cleanup.

PHYSICAL ENVIRONMENT

25.	Are tippable items >60" high seismically secured?				
26.	Are heavy/hard items secured/limited in height?				
27.	Are cabinet doors secured?				
28.	Are storage shelves provided with lips?				
29.	Is storage kept at least 18" below sprinkler heads AND ceiling throughout room or area?				
30.	Are aisles clear and unobstructed (36" lab aisles, 44" main aisles)?				
31.	Are work areas uncluttered?				
32.	Is floor in good repair?				
33.	Are all ceiling tiles/panels free of damage and in place?				
34.	Is lab under negative pressure relative to corridor?				

FIRE/LIFE SAFETY

35.	Does staff know evacuation assembly location?				
36.	Does staff know response for injuries & exposures?				
37.	Does staff know where 1 st Aid supplies are located?				
38.	Are exit corridors and doors free from obstruction created by improper storage or arrangement of furniture?				

39.	Do fire doors and doors to hazardous areas self-close and latch properly?			
40.	Are doors to labs and hazardous storage kept closed, unless held open by electromagnetic hold-open devices?			
41.	Are fire extinguishers provided within 50 feet of the lab, fully charged, pin and tamper ring in place, and up-to-date maintenance tag?			
42.	Are trash receptacles and paper located away heat or arcing sources?			
43.	Are fire alarm bells/horns/strobes free of obstruction that would hamper the operation or reduce the sound?			
44.	Is emergency equipment (i.e.: safety showers, fire alarm pull stations and fire extinguishers) physically and visually accessible?			
45.	Are signs posted by emergency showers and eyewashes?			
46.	Are temperature limit switches provided for unattended heated operations?			
47.	Refrigerators used are appropriate for the location and items stored? (No domestics in lab outside of Clean Area, FMS for flammables)			
Comments:				

ELECTRICAL/MECHANICAL SAFETY –

2pts - no storage, egress, or electrical issues**1 pt. - 3 or fewer issues,****0 pt. greater than 3 issues**

48.	Are electrical cords and plugs in good repair, not cracked, broken, or frayed?			
49.	Are wall receptacles in good repair (not broken, covers in place, etc.)?			
50.	Is the area free of any "cheater" adapters in use? (3 prong to 2 prong plugs)			
51.	Are extension cords being used only on a temporary or emergency basis?			
52.	Are (outlet strips, power bars) multiple connectors and gang plugs surge protected?			
53.	Are there fixed or portable GFCI devices used in areas that are frequently wet (within 6' of a water source)?			
54.	Are belts, pulleys, sprockets and chains, shafting, or other rotating parts of mechanical equipment properly guarded (guard openings must be less than 1/2")?			
55.	Do electrical panels or disconnects have 3' of clear space in front of them? (Temporary items such as carts, broken glass bins are ok).			
56.	Do centrifuges have covers that are used?			
57.	Are power strips mounted off the floor in case of flooding?			
58.	Do power strips have a circuit breaker?			

Comments:

RESEARCH SPECIFIC HAZARDS:

- 3pts – no violations or aren't working with these items.
- 2pts- one minor violation
- 1 pt. – two minor violations
- 0 pts. – three or more minor violations

ANIMAL RESEARCH

59.	Are animal users registered with Laboratory Animal Occupational Health Program (LAOHP)?				
60.	Are volatile or gaseous anesthetics used in connection with waste anesthetic exhaust or adsorption system?				

BIOLOGICAL SAFETY

61.	Has staff participated in Bloodborne Pathogens training within last 12 months (not applicable if no blood products are used)?				
62.	Are bio-waste containers labeled with the word "Biohazard" and the biohazard symbol?				
63.	Is red bag waste disposed by approved method?				
64.	Do tissue culture aspiration flasks have HEPA Vacu-Guard to protect house vacuum? (BSL2)				
65.	Are biological safety cabinets certified annually or posted "Caution: not certified for \geq BSL2 work"?				
66.	Are BSC lamps wiped with ethanol on a weekly basis?				
67.	Is biohazard label on lab door, refrigerators/freezers, centrifuges and work areas?				
68.	Are proper disinfectants used for agent?				

69.	Are disinfectants within active shelf life?				
<i>SHARPS MANAGEMENT</i>					
70.	Bio-sharps Management: needles, razor blades and Pasteur pipettes disposed properly (rigid, plastic sharps container)?				
71.	Are non-biohazardous sharp items, (broken glass and pointed plastic items) disposed of in a rigid, lined container marked "broken glass"?				
<i>SELECT AGENTS AND CONTROLLED SUBSTANCES</i>					
72.	Inventory & usage log maintained? SA CS				
73.	<i>Adequate storage security?</i> SA CS				
74.	<i>Disposal in accordance with UC Merced's procedures?</i> SA CS				
<i>COMPRESSED GASES</i>					
75.	Are gas cylinders capable of tipping secured?				Correct immediately.
76.	Are valve protection caps kept on cylinders when stored?				
77.	Are toxic gases stored in a ventilated cabinet/fume hood?				Correct immediately.
78.	Are oxygen cylinders stored separately from flammable gases and liquids (5' fire wall or 20' distance)?				
<i>LASERS</i>					
79.	If class 3 or 4, appropriate laser eyewear is provided?				

80.	Signage is present (class on laser, sign on door “danger” if class 3 or 4, “Caution” if less than class 3)				
81.	Class 3b or 4 has a warning system when laser powered?				
82.	Face shields are worn if using cryogens.				
83.	Beam path is known, and below eye level.				
84.	Beam stops are used.				
85.	Workers know the NHZ limits around the laser.				

RADIOACTIVITY

Comments:

CONTAINER MANAGEMENT

3 pts. – no violation

2pts – only a few deficiencies that can be remedied on the spot (1-2)

1 – multiple violations that require follow up

0 pt.- multiple violations that pose potential harm to human health and environment.

86.	Is lab staff keeping chemical inventories current within campus guidelines? (i.e. not too many flam for space, not exceeding dept. homeland sec. guidelines)				
87.	Are chemical container labels readable with regard to chemical name and hazards?				
88.	Are chemical containers in good condition (no leaking, cracked caps, rusting, crystals around neck)?				
89.	Are chemical containers kept securely closed when not in active use?				
90.	Are containers of liquid hazardous chemicals over 1 gallon capacity stored below 5 feet high?				

91.	Peroxide forming chemicals: Is open-date noted?			
92.	Does lab dispose of peroxide-formers when expired/outdated?			
93.	Is the operation of eyewash/safety showers checked monthly? (Confirm that staff observe testing).			
94.	Are flammable liquid materials stored according to UC Merced's guidelines?			
95.	Are 5-gallon flammable containers stored in FM-approved flammable material cabinet?			
96.	More than 10 gallons of class I ($fp < 73F$, $bp < 100F$) and II ($fp > 100F$, $bp > 140F$) material is not stored outside of flammable cabinets.			
97.	Are flammables materials stored away from heat and arc-sources?			
98.	Are incompatible chemical/wastes separated by distance or partition?			
99.	Are hazardous liquid chemicals/wastes stored in spill containment?			
100.	Are corrosive liquids, including wastes, stored below shoulder level?			
101.	Are waste containers compatible, closed, and labeled properly?			
102.	Are stored wastes within time limits? (180 days)			
103.	Are employees instructed in incidental spill response?			
104.	Are fume hoods in working order (flow indicator, sash, lights)?			

105.	Is lab using fume hood correctly: Is the back of the fume hood clear of obstructions, equipment, is work contained past the front of the hood by 6", sash position does not exceed approved working height and is down when not in use?				
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Comments:

PERSONAL PROTECTIVE EQUIPMENT (PPE) and HYGIENE

2pts – all lab workers wear appropriate PPE while working in lab

1pt – appropriate PPE provided, but workers don't use, lab staff wearing inappropriate lab attire (shorts, open toed shoes)

Opt- appropriate PPE not provided, lack of ppe could lead to serious injury

106.	Is PPE provided (may include safety glasses, goggles, gloves, aprons, faceshields)?				
107.	Is staff wearing appropriate PPE?				
108.	Is PPE stored in a clean and sanitary location?				
109.	Is staff conscientious removing PPE prior to exiting lab, handling telephones, etc.?				
110.	Have respirator/dust mask users been evaluated by EHS for respirator use?				
111.	Have respirator/dust mask users been given appendix D of OSHA's respiratory protection standard?				
112.	Is eating, drinking, and cosmetic use occurring only in areas signed as "Clean Areas" and adequately separated from hazardous materials use and storage?				
113.	Are refrigerators, microwaves and freezers labeled regarding the storage of hazardous materials or food items?				

Appendix N: Segregation of Incompatible Chemicals

Table N.1 contains a list of incompatible chemicals. The following chemicals, listed in the left column, should not be used with chemicals listed in the right column, except under specially controlled conditions. Chemicals in the left column should not be stored in the immediate area with chemicals in the right column. Incompatible chemicals should always be handled, stored or packed so that they cannot accidentally come into contact with one another. This list is representative of chemical incompatibilities and is not complete, nor are all incompatibilities shown.

Table N.1 – Incompatible Chemicals

Chemical	Keep Out of Contact with:
Alkaline metals, such as powdered aluminum, magnesium, sodium, potassium, etc.	Carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide and water
Acetic Acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides and permanganates
Acetylene	Chlorine, bromine, copper, fluorine, silver and mercury
Ammonia	Mercury, chlorine, calcium hypochlorite, iodine, bromine and hydrofluoric acid
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustible materials
Carbon, activated	Calcium hypochlorite
Copper	Acetylene and hydrogen peroxide
Chromic acid	Acetic acid, naphthalene, camphor, glycerin, turpentine, alcohol and flammable liquids
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane, hydrogen, sodium carbide, turpentine, benzene and finely divided metals
Cyanides	Acids - organic or inorganic
Hydrogen peroxide	Copper, chromium, iron, most metals, alcohols, acetone, organic materials, aniline, nitromethane, flammable liquids and combustible materials
Hydrogen sulfide	Fuming nitric acid and oxidizing gases
Hydrocarbons (butane, propane, benzene, gasoline, turpentine etc.)	Fluorine, chlorine, bromine, chromic acid and sodium peroxide
Iodine	Acetylene, ammonia and hydrogen

Nitric acid	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass and any heavy metals
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, ether, oils and grease
Phosphorous	Oxidizing agents, oxygen, strong bases
Potassium chlorate	Sulfuric and other acids
Potassium permanganate	Glycerin, ethylene glycol, benzaldehyde and sulfuric acid
Sodium	Carbon tetrachloride, carbon dioxide and water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate and furfural
Sulfides, inorganic	Acids Sulfuric acid Potassium chloride, potassium perchlorate and potassium permanganate

Special Segregation of Incompatible Chemicals

In addition to the segregation noted in Table N.1, dangerously incompatible substances, even in small quantities, should not be stored next to each other on shelves or in such a position that accidental rupture of containers may allow mixing. Table N.2 contains examples of dangerously incompatible substances. Table N.3 contains examples of incompatible oxidizing agents and reducing agents.

Table N.2 – Dangerously Incompatible Substances

Chemical	Keep out of contact with:
Chlorine	Acetylene
Chromic acid	Ethyl alcohol
Oxygen (compressed, liquefied)	Propane
Sodium	Chloroform and aqueous solutions
Nitrocellulose (wet, dry)	Phosphorous
Potassium permanganate	Sulfuric acid
Perchloric acid	Acetic acid
Sodium chlorate	Sulfur in bulk

Table N.3 – Incompatible Oxidizing Agents and Reducing Agents

Oxidizing Agents	Reducing Agents
Chlorates	Ammonia
Chromates	Carbon
Dichromates	Metals
Chromium trioxide	Metal hydrides
Halogens	Nitrates
Halogenating agents	Organic Compounds
Hydrogen peroxide	Phosphorus
Nitric acid	Silicon
Nitrates	Sulfur
Perchlorates	
Peroxides	
Permanganates	
Persulfates	

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Appendix O: Hazardous Waste Pick-Up

- Waste is picked up by EH&S once per week. For laboratory clean-outs, large, or special pick-ups, call your health and safety officer for instructions. Label all hazardous chemical waste using an Online Hazardous Waste Tag
- Materials should be segregated according to hazard classification for transportation. Each hazard class should have a separate secondary container
- Do not transport materials on public streets. Hazardous waste can never be left unattended in any public area
- Wear appropriate personal protective equipment such as safety glasses, laboratory coats and closed-toed shoes

Waste Disposal Information

All waste must be labeled with a UC Online Hazardous Waste Tag when the first drop of waste is added.

Container Requirements

- **Liquid Waste:**
 - Containers must be free of exterior contamination
 - Containers must be chemically compatible and the size should be suitable for the material stored
 - Containers must be in good condition with screw tops or sealed lids
 - Containers MUST NOT be leaking, rusting or have any other defects
 - Containers MUST NOT be filled to the top. (Leave 10% air space)
- **Dry Waste** must be double-bagged in transparent, sturdy bags and cannot have sharp or protruding edges
- **Unknown chemicals** The cost of identifying an unknown for disposal may be recharged to the lab.

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APPENDIX P: Spill Clean-up Procedures

Laboratory personnel can clean up small spills if trained and competent to do so. Small spills include chemical spills that are up to 1 liter in size and of limited toxicity, flammability and volatility, and mercury spills from broken thermometers (about 1.5 grams). If respiratory protection is needed for spill cleanup, the spill is too large to be handled by laboratory personnel – dial **9-911 or your health and safety officer**. Commercial chemical and mercury spill kits are available, which include protective equipment such as goggles and gloves, neutralizing and absorbing materials, bags, and scoops. You can also make your own spill kits to include the materials described below.

Chemical Spills:

- Sodium Bicarbonate
- Citric Acid
- Vermiculite or other diking material
- pH paper
- 1 pair neoprene or nitrile gloves
- 1 pair goggles
- 1 scoop
- Spill pillows, sorbent pads
- Disposable shoe covers (plastic bags may work)

Mercury Spills:

- Disposable gloves
- Disposable shoe covers (plastic bags will work)
- Index card or rubber squeegee
- Disposable syringe or a vacuum trap flask fitted with tubing or Pasteur pipette
- Inactivating solutions and/or powders

Weak Inorganic Acid or Base Spill Clean Up Procedure

1. Wear gloves, goggles, laboratory coat and shoe covers.
2. To clean-up a spill of weak inorganic acid or base, neutralize the spilled liquid to pH 5 to 8 using a **Neutralizing Agent** such as:
 - Sodium bicarbonate
 - Sodium bisulfate
 - Soda ash
 - Citric acid
3. Absorb the neutralized liquid with an **Absorbent** such as:
 - Sorbent pads
 - Sponges
 - Diatomaceous earth
 - Paper towels
 - Dry sand
 - Vermiculite

4. Rinse the absorbent pads or sponges in a sink with water. Scoop or place the other absorbent materials into a clear plastic bag. Double bag and tag the bag with a chemical waste tag. **Solvent Spill Clean Up Procedure**

1. Absorb the spill with a non-reactive material such as:
 - Vermiculite
 - Dry sand
 - Paper towels
 - Sponges
2. Package as described above. Do not rinse or dispose of any chemicals down the sink or into any drain.

Broken Thermometer Clean Up Procedure

1. Clean up the spill immediately after it has occurred.
2. Prevent the spread of the spilled mercury. Do not allow people to walk through spill area.
3. Wear disposable gloves and shoe covers or place plastic bags over your shoes during the clean-up.
4. Push the mercury droplets together into a bead using an index card or rubber squeegee.
5. Aspirate the beaded mercury into a disposable syringe, or use a disposable Pasteur Pipette attached with tubing to a vacuum flask to aspirate the mercury into the flask. The flask should contain water. Always have a second vacuum flask between the mercury flask and the house vacuum.
6. Chemically inactivate any residual mercury. There are several methods to inactivate the residual mercury including:
 - Use a commercial inactivating powder following its directions for use
 - Sprinkle zinc powder over the spill area. Then moisten the zinc with a 5 to 10 percent sulfuric acid solution until a paste is formed. Scour the contaminated surface and allow the paste to dry. Sweep up the dried paste
 - Wash the contaminated area with a detergent solution. Rinse and then swab the area with a calcium polysulfide solution containing two to four tablespoons of calcium polysulfide per gallon of water
7. Place the collected mercury and materials used in the clean-up into a clear plastic bag. Double bag and label the waste. Take it to the chemical waste pick-up for your building.

If a large spill occurs, call 9-911 from a campus phone or 911 from an off-campus or cell phone or your health and safety officer (228-2EHS).

LAB EMERGENCY

Call **9-911** (from a campus phone) or 911 from a cell phone

Medical Emergency Dial 911	<p>LIFE THREATENING EMERGENCY, AFTER HOURS, WEEKENDS AND HOLIDAYS: Dial 9-911 from a campus phone or 911 from a cell phone. <i>Note: All serious injuries must be reported to EH&S at 228-4234 within 8 hours.</i></p> <p>NON-LIFE THREATENING EMERGENCY: Go to the Olivewood Meadows Occupational Health Facility (OHF) at 374 Olive Ave. Hours: M – F 8 a.m. to 5p.m. At all other times report to Mercy Medical Center (emergency room) at 333 Mercy Ave. <i>Note: All serious injuries must be reported to EH&S at 228-4234 within 8 hours.</i></p> <p>Needle stick/puncture exposure: Wash the affected area with antiseptic soap and warm water for 15 minutes. For mucous membrane exposure, flush the affected area for 15 minutes using an eyewash station. Seek medical attention listed under "non-life threatening emergency". <i>Note: All needle stick/puncture exposures must be reported to EH&S at 228-4234 within 8 hours.</i></p>
Fire Dial 911	<p>SMALL FIRE (trash can size) – If you have been trained, you may put out the fire using a fire extinguisher. Report the fire by calling 911. Notify EH&S at 228-4473 and Facilities Management 228-2980 anytime a fire extinguisher is used or discharged.</p> <p>LARGE FIRE (requiring more than 1 fire extinguisher) – Evacuate the area. Close all doors and windows as you leave. Close the fume hood sash if the fire is in the fume hood. Activate the nearest alarm. Call 911. Evacuate the area using the stairwells. Do not use the elevator.</p> <p>CLOTHES ON FIRE – Use nearest safety shower. If none immediately available, STOP-DROP-ROLL to quickly smother the fire. Seek medical attention. Notify supervisor and EH&S at 228-4234 immediately.</p>
Chemical Spill Dial 911 and 228-7864	<p>SPILL – Help contaminated or injured persons. Evacuate the spill area. Avoid breathing vapors. Eliminate sources of ignition if the chemical is flammable. If possible, confine the spill to a small area using a spill kit or absorbent material. Keep others from entering contaminated area (e.g., use caution tape, barriers, etc.).</p> <p>SMALL (<1 L) – If you have training, you may assist in the clean-up effort. Use appropriate personal protective equipment and clean-up material for chemical spilled. Double bag spill waste in clear plastic bags, label, and take to the next chemical waste pick-up.</p> <p>LARGE (>1 L) – Dial 911 and EH&S at 228-7864 or 205-8176 for assistance.</p> <p>CHEMICAL SPILL ON BODY OR CLOTHES – Remove clothing and rinse body thoroughly in emergency shower for at least 15 minutes. Seek medical attention. Notify supervisor and EH&S at 228-7864 immediately.</p> <p>CHEMICAL SPLASH INTO EYES – Immediately rinse eyeball and inner surface of eyelid with water for 15 minutes by forcibly holding the eye open. Seek medical attention. Notify supervisor and EH&S at 228-7864 immediately.</p>
Bio-hazardous Spill Dial 911 and 228-4639	<p>CONCENTRATED, >100 ml OF BSL-2, OR SPILL IN PUBLIC AREA – Do not attempt to clean it up. Keep people from entering. Dial 911 and EH&S at 228-4639 or 756-2937 for assistance.</p> <p>BIOHAZARDOUS SPILL ON BODY OR CLOTHES – Immediately remove contaminated clothing and place in a red biohazard bag. Wash with antiseptic soap and water for at least 15 minutes. Seek medical attention. Notify supervisor and EH&S at 228-4639 or 756-2937 immediately.</p> <p>GENERAL BIOHAZARD SPILL CLEAN-UP – Use clean personal protective equipment appropriate for the lab Biosafety Level. Place absorbent pads over area. Use appropriate disinfectant and carefully pour disinfectant starting from the outside to the inside of material (do not spray the disinfectant to minimize aerosol). Allow a minimum 20 minutes of contact time. Remove any sharps using forceps and discard in a sharps container. Dispose clean-up materials as biohazardous waste for proper waste disposal. Repeat clean-up process as necessary. Remove protective clothing and segregate for disposal or laundering. Wash hands with soap and water. Notify supervisor and EH&S at 228-4639 or 756-2937 immediately.</p> <p>UNCONTROLLED SPILLS (e.g., unknown biohazard, outside of a biosafety cabinet, unsure of the clean-up) – Notify room occupants of spill. Immediately exit the room if you are not wearing the appropriate personal protection. Mark-off the area using tape and warning signs. Everyone should wash their hands and face or shower using a disinfecting soap. Wait at least 30 minutes for aerosol to settle. Dial 911 and EH&S at 228-4639 or 756-2937 for assistance.</p>
Radioactive Spill Dial 911 and 228-7864	<p>SMALL (≤ 1 mCi, contained in labs, not in public areas, and non-alpha emitters) – Cover spill with absorbent material. Notify others in the area of the spill. If comfortable, continue clean-up of the area with absorbent materials. Use disposable gloves and change frequently. Place all contaminated materials in a radioactive waste bag. Monitor spill area and all personnel participating in decontamination efforts with appropriate survey instrument. Record incident in the laboratory survey log and call Radiation Safety at 228-7864.</p> <p>LARGE (≥ 1 mCi, not contained in labs, in public area, or alpha-emitters) – Contain spill with absorbent material and shield spill if necessary. Evacuate all personnel from immediate area and prevent entry of others. Personnel that are potentially contaminated should be surveyed with appropriate survey instruments. Dial 911 and EH&S at 228-7864 for assistance.</p> <p>PERSONAL CONTAMINATION – Immediately remove contaminated clothing. Rinse area, especially between fingers and around fingernails with water first, then wash with mild detergent. Dial 911 and EH&S at 228-7864 for assistance.</p>
Earthquake	<p>DURING EARTHQUAKE - Take cover in the laboratory underneath a table or desk, or move to the hallway and brace yourself against the wall, covering your head with your arms. After the shaking has stopped:</p> <ul style="list-style-type: none"> • Remain in the building if the quake was minor • Evacuate the building if the quake was severe. Do not use the elevators; use the stairwells. • After evacuation, report to your designated meeting place (main campus – quad, Caslte – back parking lot)

*Note: All serious injuries must be reported within 8 hours to the EH&S 228-4234 during normal business hours, or CAT-COPS at all other times.
All fires, large spills and exposures must be reported to the EH&S at 228-4234 as soon as possible.*

Revised 1/2014

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Responsible Officer:	Chief Risk Officer
Responsible Office:	RK - Risk / EH&S
Issuance Date:	[Issuance Date]
Effective Date:	3/1/2013
Scope:	<p>This policy and regulatory standards require the supervisor to select Personal Protective Equipment (PPE) for workers under their supervision based on an assessment of hazards in the workplace which those workers are likely to encounter. Supervisors are required to inform such workers of the selection decisions, and to have their workers follow those decisions when obtaining PPE. PPE will be provided to workers at no cost.</p> <p>This policy applies to students enrolled in academic courses in which PPE is required by the instructor and/or indicated in the course syllabus.</p>

Contact: Email: Phone #:	Erike Young eyoung@ucop.edu (510) 987- 0170
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I. POLICY SUMMARY

The University of California is committed to providing a healthy and safe working environment for all members of the campus community. This Personal Protective Equipment (PPE) policy is designed to prevent workplace injuries and illnesses for all academic appointees, staff, students, and visitors.

II. DEFINITIONS

Hazardous Materials: Hazardous materials, for the purposes of this policy, are chemical or biological agents that have been identified as a health or physical hazard. Unsealed radioactive materials are also included as “hazardous materials.” Additional guidance is included in Appendix A.

Laboratory/Technical Areas: A laboratory/technical area is a location where the laboratory use or storage of hazardous materials occurs or where laboratory equipment may present a physical hazard. It includes, but is not limited to:

Research laboratories	Cold rooms
Teaching laboratories	Machine and other Workshops
QA/QC and analytical laboratories	Vivaria
Stock rooms	Surgery/Operating rooms
Storage rooms	Visual/performing arts studios and shops
Waste accumulation areas/locations	

Personal Protective Equipment (PPE): Personal protective equipment is equipment worn to minimize exposure to a variety of hazards. Examples of PPE include such items as lab coats, gloves, foot protection (steel-toed shoes), eye protection (safety glasses or goggles), protective hearing devices (earplugs, muffs), hard hats, respirators, fall protection harnesses, etc.

Physical Hazards: Physical hazards are identified as substances, equipment, or activities that can threaten physical safety. Physical hazards can include but are not limited to: impact (falling objects), fall hazards, extreme pressures, temperature extremes (heat/cold), radiation (ionizing and non-ionizing), noise, vibration, electrical, light (optical), welding, cutting, brazing).

Student: An individual enrolled in an academic class.

Supervisor: An employee who may have authority to hire personnel, evaluate performance, direct work assignments, apply progressive discipline, direct resources to correct identified safety issues. For purposes of this Policy, this includes a Principal Investigator, area manager, unit manager, project manager, superintendent, and foreman/person. Unless specified in writing, the default “supervisor” in laboratory/technical areas is the Principal Investigator.

Use or Storage: For the purposes of this Policy, “use or storage” includes those operations where workers are directly manipulating hazardous materials, adjacent to or in proximity to a hazard or in areas where there is a reasonable risk of exposure. Reasonable risk of exposure includes all activities identified in the hazard assessment that pose an exposure risk to the worker.

Worker: For purposes of this policy, a worker is an individual who actively performs work functions with hazardous materials or equipment in a laboratory/technical area. A “worker” may be faculty, staff, student volunteer assisting in a non-academic class, or visitor/visiting scholar. For the purpose of this definition, “worker” excludes individuals who only passively participate in tours, lectures, conferences, etc.

¹ Much of the information required for the form can be found on the chemical's safety data sheet (SDS) or container label

III. POLICY TEXT

Hazards exist in every University workplace and can take many different forms: sharp edges, falling objects, flying sparks, chemicals, noise, and a myriad of other potentially dangerous situations. This policy requires that the University protect its workers from workplace hazards that can cause injury.

Controlling a hazard at its source is the best way to protect employees. Depending on the hazard or workplace conditions, the preferred solution is the use of engineering or work practice (administrative) controls to manage or eliminate hazards to the greatest extent possible. When engineering or administrative (work practice) controls are not feasible or do not provide sufficient protection, supervisors must provide personal protective equipment (PPE) to their workers and ensure its use.

Failure/refusal to wear required PPE is a basis for discipline, in accordance with locally-established procedures. A student not wearing course required PPE in a laboratory/technical area may not participate in lab activities until such PPE is worn.

This policy sets minimum requirements; each campus may develop policies and procedures that provide equivalent protection.

A. General Program Requirements

1. For workers:

a. Perform Hazard Assessment

Each supervisor shall assess the workplace to determine if hazards are present, or are likely to be present, which necessitate the use of personal protective equipment (PPE).

Each supervisor shall verify that the required workplace hazard assessment has been performed through a written certification that identifies the workplace evaluated; the person certifying that the evaluation has been performed; the date(s) of the hazard assessment; and, which identifies the document as a certification of hazard assessment. Hazard assessments that indicate less than the minimum PPE for a laboratory/technical area as stated in section B requires written approval from Environment(al) Health and Safety (EH&S) (See section B3a).

A completed standard operating procedure, job hazard analysis, or other similar document which includes a workplace hazard assessment can be used to satisfy this requirement.

b. Identify Required PPE

Each supervisor, based upon the hazard assessment, shall ensure that the appropriate personal protective equipment has been identified. The PPE must be the proper fit and design for the user and not interfere with the ability of the worker to work safely. The PPE will be provided to the worker at no cost.

¹ Much of the information required for the form can be found on the chemical's safety data sheet (SDS) or container label

c. Training

Each supervisor will assure workers know how to properly wear, adjust and maintain assigned PPE. Workers will demonstrate understanding of the proper use of assigned PPE. Training will be documented.

d. Maintenance and Replacement

Each worker is responsible for properly wearing required PPE. Each worker is responsible for informing their supervisor when worn or damaged PPE needs to be replaced.

e. Evaluating the Appropriateness of Identified PPE

Each supervisor is responsible for periodically re-evaluating the selection and use of PPE in work areas under their control. The hazard assessment should be repeated when new hazards are identified or introduced into the workplace or at least every three (3) years.

2. For students:

Academic courses which include laboratory, shop or field work are required to indicate PPE requirements as part of the course syllabus. These PPE items shall be the responsibility of the student to obtain and wear as part of the class. Common communal PPE such as thermal protective, welding aprons, face shields, etc., will be provided by the sponsoring department. The academic department is responsible for ensuring that students are familiar with and properly using required protective devices.

B. Minimum Personal Protective Equipment Requirements for Laboratories/Technical Areas

The following minimum PPE requirements pertain to all laboratories/technical areas where use or storage of hazardous materials occurs or a physical hazard exists. (See definitions). This section should be used as the basis for developing the required PPE elements to include in the course syllabus for laboratory classes. The wearing of required PPE may only be modified as determined by the hazard assessment. (See section III.A.1a).

1. When occupying a Laboratory/Technical Area

- a. Full length pants, or equivalent, and closed toe/heel shoe attire must be worn at all times by all workers who are occupying or entering a laboratory/technical area. The area of skin between the shoe and ankle should not be exposed.
- b. Protective eyewear must be worn at all times by all workers who are occupying or entering a laboratory/technical area. All protective eyewear must meet American National Standards Institute (ANSI) standards and be appropriate for the work being done. Typical prescription spectacles are not suitable eye protection. Prescription safety glasses are available through individual campus procurement offices.

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- c. Laboratory coats, or equivalent protective garments, are required to be worn by all workers when occupying a laboratory/technical area.
 - i. Laboratory coats must be appropriately sized for the worker. Coats should be buttoned to their full length. Laboratory coat sleeves must be of a sufficient length to prevent skin exposure while wearing gloves.
 - ii. Flame Resistant (FR-rated) laboratory coats must be worn when working with any amount of pyrophoric materials or quantities of flammable liquids as described in the hazard assessment.
 - iii. Any protective clothing that becomes contaminated with hazardous materials must be decontaminated before it leaves the laboratory or appropriately discarded.
 - iv. Laboratory coats shall not be laundered at private residences or public laundry facilities. Campuses are responsible for providing suitable laundry services to maintain required laboratory coats.

Exception: Students enrolled in an academic course are responsible for laundering their non-contaminated lab coats according to manufacturer instructions.

2. When working directly with or handling hazardous materials

- a. Protective gloves must be worn while using any hazardous materials, hot or cold liquids (including cryogenics) or objects that pose a risk of thermal burns, items having physical hazards, or equipment that may cause hand injury. These gloves must be appropriate for the material or process being used and must not interfere with the ability of the worker to work safely. The Safety Data Sheet (SDS) for the material and the manufacturer-specific glove selection guide should be referenced to determine appropriate glove type.
- b. Some operations and procedures may warrant additional PPE, as indicated by the Safety Data Sheet (SDS), the Standard Operating Procedures (SOP), facility policies, regulatory requirements, or the hazard assessment. These might include face shields, aprons, respiratory protection, hearing protection, etc.

3. Exceptions

These requirements will not apply to laboratories/technical areas which have been designated and posted as hazardous materials free areas. In order to qualify as a hazardous materials free area, a laboratory must obtain written approval and from their campus Environment(al) Health and Safety (EH&S). EH&S has the final authority for determining whether any area is classified as non-hazardous.

¹ Much of the information required for the form can be found on the chemical's safety data sheet (SDS) or container label

IV. COMPLIANCE / RESPONSIBILITIES

The Chancellor has overall responsibility for compliance with health and safety requirements at all facilities and programs under her/his control.

Vice Chancellors/Directors/Deans/Departments Chairs are responsible for communicating, promoting and enforcing the Policy in areas under their control.

The Campus or School Laboratory and/or Chemical Safety Committee is responsible for promoting a safe working environment in all research and teaching laboratories on campus.

Supervisors are responsible for complying with this policy and ensuring their staff complies with this policy. Supervisors are responsible for conducting and documenting the hazard assessment. Supervisors are also responsible for ensuring their staff receives both the required PPE identified in the assessment appropriate and documented training on proper use of the PPE. Noncompliance with the policy is handled in accordance with Personnel Policies for Staff Members (PPSM) policies 62-65 pertaining to disciplinary actions and Academic Personnel Manual (APM) policies 015-016 pertaining to the Faculty Code of Conduct and administration of discipline.

Workers are responsible for knowing the PPE requirements for areas in which they work or enter, and for properly wearing PPE as established in this policy and in the hazard assessment. All workers are responsible for completing training, for knowing how to use PPE, for knowing how to properly put on and take off required PPE, and for knowing how to care for and maintain PPE. They are responsible for informing others in the area of these requirements and reporting unsafe conditions to their supervisor, or EH&S. Workers are NOT responsible for purchasing their own PPE. As applicable, a staff employee may address issues of noncompliance with this Policy through the complaint resolution processes described in PPSM 70 and II-70 (Complaint Resolution) and PPSM 71 and II-70 (Resolution of Concerns) or Collective Bargaining Agreement.

Students are responsible for obtaining course required PPE as noted in the course syllabus or indicated by the instructor._

The Office of Environment(al), Health & Safety (EH&S) is responsible for providing interpretation and clarification regarding this Policy. EH&S will also provide consultation and tools to assist supervisors in performing the hazard assessment and with developing training. In cases where work activities pose an immediate danger to life or health, designated EH&S staff have the responsibility and authority to order the temporary cessation of the activity until the hazardous condition is abated.

The Office of Human Resources is responsible for all employee and labor relations issues, including interpretation and clarification of Personnel Policies and Collective Bargaining Agreements related to this Policy.

V. PROCEDURES

Not applicable

¹ Much of the information required for the form can be found on the chemical's safety data sheet (SDS) or container label

VI. Related information

Appendix A – Hazardous Materials

8 CCR 3380 Personal Protective Devices: (See <http://www.dir.ca.gov/title8/3380.html>)

8 CCR 5191 Laboratory Standard: (See <http://www.dir.ca.gov/title8/5191.html>)

8 CCR 5194 Hazard Communication: (See <http://www.dir.ca.gov/title8/5194.html>)

8 CCR 3203 IIPP: (See <http://www.dir.ca.gov/title8/3203.html>)

8 CCR 5209: Listed Carcinogens (See <http://www.dir.ca.gov/title8/5209.html>)

VII. FREQUENTLY ASKED QUESTIONS

Not applicable.

VIII. REVISION HISTORY

This is the first version of this policy.

¹ Much of the information required for the form can be found on the chemical's safety data sheet (SDS) or container label

Appendix A

Hazardous Materials

Hazardous materials may be described using the following characteristics or regulatory definitions. This list is to be used as a guideline and allows for some laboratory/ technical areas to be classified as non-hazardous materials areas. It does not supersede Cal/OSHA regulations or accepted safe work practices for specific materials. The container label and the Safety Data Sheet for the material should be consulted to determine the hazard classification(s) of a particular substance.

- a) Corrosives are any chemical that causes visible destruction of, or irreversible alterations in, living tissue at the site of contact. *Examples: hydrochloric acid, sulfuric acid, sodium hydroxides, potassium hydroxides.*
- b) Materials recognized as readily absorbed through the skin. *Examples: phenol, THF, DMSO, benzene, carbon disulfide, toluene.*
- c) Skin or eye irritants are chemicals which are not corrosive, but which cause a reversible inflammatory effect on living tissue by chemical action at the site of contact. *Examples: xylenes, formamide, many amines like triethanolamine, carbon tetrachloride, perchloroethylene, many inorganic salts like cobalt and nickel sulfate*
- d) Flammable liquids having a flash point not more than 93°C. *Examples: organic solvents, ethers, alcohols, toluene, pentane, acetone*
- e) Violently air-reactive or water-reactive chemicals, including pyrophorics (substances that spontaneously ignite in air). *Examples: sodium or potassium metal, diethyl zinc, lithium aluminum hydride, t-butyl lithium, aluminum alkyls, calcium carbide, phosphine*
- f) Carcinogens or Mutagens *Examples: formaldehyde, dichloromethane, benzene, chloroform,*
- g) Reproductive Hazards. *Examples: acrylamide, Cd, Pb, Hg, Cr(VI), carbon disulfide, toluene, chloroform, ethylene glycol ethers*
- h) Toxic or Highly Toxic Chemicals – a materials likely to be fatal or toxic if inhaled, ingested or if contacted by skin.
- i) Oxidizing agents – a material that, generally by yielding oxygen, causes or contributed to the combustion of other material. *Examples: nitric and perchloric acids, chromates, nitrates, nitrites, hydrogen peroxide, chlorates*
- j) Any unsealed radioactive material.
- k) Biological materials classified as Risk Group 2, or greater.
- l) Centers for Disease Control Select Agent Toxins

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Appendix S: Glossary

ACGIH - The American Conference of Governmental Industrial Hygienists is a voluntary membership organization of professional industrial hygiene personnel in governmental or educational institutions. The ACGIH develops and publishes recommended occupational exposure limits each year called Threshold Limit Values (TLVs) for hundreds of chemicals, physical agents, and biological exposure indices.

ACTION LEVEL - A concentration designated in Title 8, California Code of Regulations for a specific substance, calculated as an eight (8)-hour time weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

AEROSOL - Liquid droplets or solid particles dispersed in air that are of fine enough size (less than 100 micrometers) to remain dispersed for a period of time.

ASPHYXIANT - A chemical (gas or vapor) that can cause death or unconsciousness by suffocation. Simple asphyxiants, such as nitrogen, either use up or displace oxygen in the air. They become especially dangerous in confined or enclosed spaces. Chemical asphyxiants, such as carbon monoxide and hydrogen sulfide, interfere with the body's ability to absorb or transport oxygen to the tissues.

"C" OR CEILING - A description usually seen in connection with a published exposure limit. It refers to the concentration that should not be exceeded, even for an instant. It may be written as TLV-C or Threshold Limit Value - Ceiling. (See also Threshold Limit Value).

CARCINOGEN - A cancer-producing substance or physical agent in animals or humans. A chemical is considered a carcinogen or potential carcinogen if it is so identified in any of the following:

- National Toxicology Program, "Annual Report of Carcinogens" (latest edition)
- International Agency for Research on Cancer, "Monographs" (latest edition)
- OSHA, 29 CFR 1910, Subpart Z, Toxic and Hazardous Substances

CHEMICAL HYGIENE OFFICER - 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.

CHEMICAL HYGIENE PLAN - 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 OSHA regulation 29 CFR 1910.1450.

COMBUSTIBLE LIQUID - Any liquid having a flashpoint at or above 100°F (37.8°C) but below 200°F (93.3°C) except any mixture having components with flashpoints of 200°F or higher, the total volume of which make up 99% or more of the total volume of the mixture.

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

CORROSIVE - A substance that, according to the DOT, causes visible destruction or permanent changes in human skin tissue at the site of contact or is highly corrosive to steel.

DESIGNATED AREA - An area which has been established and posted with signage for work involving hazards (e.g., "select carcinogens," reproductive toxins, or substances which have a high degree of acute toxicity). A designated area may be the entire laboratory, an area of a laboratory, or a device such as a laboratory hood.

EMERGENCY - Any potential occurrence, such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment which could result in an uncontrolled release of a hazardous chemical into the workplace.

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

FLAMMABLE - A chemical that falls into one of the following categories:

1. Flammable aerosol - 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. Flammable gas - a gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13% by volume or less; or a gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12% by volume, regardless of the lower limit;
3. Flammable liquid - any liquid having a flashpoint below 100°F (37.8°C), except any mixture having components with flashpoints of 100°F (37.8°C) or higher, the total of which make up 99% or more of the total volume of the mixture; or
4. Flammable solid - a solid, other than a blasting agent or explosive as defined in 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and, when ignited, burns so vigorously and persistently as to create a serious hazard. 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 greater than one-tenth of an inch per second along its major axis.

FLASHPOINT - The minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite in the presence of an ignition source or when tested as follows:

1. Tagliabue Closed Tester (See American National Standard Method of Test for Flashpoint 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°F (37.8°C) or that contain suspended solids and do not have a tendency to form a surface film under test;
2. Pensky-Martens Closed Tester (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D-73-79) for liquids with a viscosity equal to or

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greater than 45 SUS at 100oF (37.8°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 Flashpoint of Setaflash Closed Tester (ASTM D-3278-78)). Organic peroxides, which undergo auto accelerating thermal decomposition, are excluded from any flashpoint determination methods specified above.

GENERAL VENTILATION - Also known as general exhaust ventilation, this is a system of ventilation consisting of either natural or mechanically induced fresh air movements to mix with and dilute contaminants in the workroom air. This is not the recommended type of ventilation to control contaminants that are highly toxic, when there may be corrosion problems from the contaminant, when the worker is close to where the contaminant is being generated, and where fire or explosion hazards are generated close to sources of ignition. (See Local Exhaust Ventilation)

GHS – (Globally Harmonized System for classifying and labeling chemicals) – Designed to uniformly define and communicate health, physical and environmental hazards of chemicals on a global scale.

HAZARD ASSESSMENT - A formal procedure undertaken by the supervisor in which occupational hazards for all employees are described per procedure or task, and by affected body part(s) or organ(s), and which is documented and posted in the workplace with all personal protective equipment requirements.

HAZARD WARNING - Any words, pictures, symbols or combination thereof appearing on a label or other appropriate form of warning which convey the hazards of the chemical(s) in the container(s).

HAZARDOUS MATERIAL - Any material which is a potential/actual physical or health hazard to humans.

HAZARDOUS MATERIAL (DOT) - A substance or material capable of posing an unreasonable risk to health, safety, and property when transported including, but not limited to, compressed gas, combustible liquid, corrosive material, cryogenic liquid, flammable solid, irritating material, material poisonous by inhalation, magnetic material, organic peroxide, oxidizer, poisonous material, pyrophoric liquid, radioactive material, spontaneously combustible material, an water-reactive material.

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

1. OSHA, 29 CFR 1910, Subpart Z, Toxic and Hazardous Substances;
2. "Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment," ACGIH (latest edition);
3. "The Registry of Toxic Effects of Chemical Substances," NIOSH (latest edition); or
4. Director's List.

¹ Much of the information required for the form can be found on the chemical's safety data sheet (SDS) or container label

HIGHLY TOXIC - A substance falling within any of the following categories:

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

IGNITABLE - A solid, liquid or compressed gas waste that has a flashpoint of less than 140°F. Ignitable material may be regulated by the EPA as a hazardous waste as well.

INCOMPATIBLE - The term applies to two substances to indicate that one material cannot be mixed with the other without the possibility of a dangerous reaction.

IRRITANT - A substance which, by contact in sufficient concentration for a sufficient period of time, will cause an inflammatory response or reaction of the eye, skin, nose or respiratory system. The contact may be a single exposure or multiple exposures. Some primary irritants: chromic acid, nitric acid, sodium hydroxide, calcium chloride, amines, metallic salts, chlorinated hydrocarbons, ketones and alcohols.

LABEL - Any written, printed or graphic material displayed on or affixed to containers of chemicals, both hazardous and non-hazardous.

LABORATORY TYPE HOOD - 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 USE OF HAZARDOUS CHEMICALS - Handling or use of such chemicals in which all of 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 nor in any way simulate a production process; and
4. "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

LHAT (Lab Hazard Assessment Tool) – An online tool that allows a PI and EHS to track the lab roster, list required PPE for the space, document PPE training and issuance.

LOCAL EXHAUST VENTILATION (Also known as exhaust ventilation) – A ventilation system that captures and removes the contaminants at the point they are being produced before they escape into the

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workroom air. The system consists of hoods, ductwork, a fan, and possibly an air-cleaning device. Advantages of local exhaust ventilation over general ventilation include: it removes the contaminant rather than dilutes it, requires less airflow and, thus, is more economical over the long term; and the system can be used to conserve or reclaim valuable materials; however, the system must be properly designed with the correctly shaped and placed hoods, and correctly sized fans and ductwork.

SAFETY DATA SHEET (SDS) - Written or printed material concerning a hazardous chemical which is prepared in accordance with paragraph (g) of 29 CFR 1910.1200. Formerly known as Material Safety Data Sheet (MSDS)

MEDICAL CONSULTATION - A consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

MIXTURE - Any combination of two or more chemicals if the combination is not, in whole or in part, the result of a chemical reaction.

MUTAGEN - Anything that can cause a change (or mutation) in the genetic material of a living cell.

NFPA - The National Fire Protection Association; a voluntary membership organization whose aims are to promote and improve fire protection and prevention. NFPA has published 16 volumes of codes known as the National Fire Codes. Within these codes is Standard No. 705, "Identification of the Fire Hazards of Materials". This is a system that rates the hazard of a material during a fire. These hazards are divided into health, flammability, and reactivity hazards and appear in a well-known diamond system using from zero through four to indicate severity of the hazard. Zero indicates no special hazard and four indicates severe hazard.

NIOSH - The National Institute for Occupational Safety and Health; a federal agency that among its various responsibilities trains occupational health and safety professionals, conducts research on health and safety concerns, and tests and certifies respirators for workplace use.

OHF – Occupational Health Facility. Contact information for Olivewood Meadows is in section 1.

ODOR THRESHOLD - The minimum concentration of a substance at which a majority of test subjects can detect and identify the substance's characteristic odor.

OXIDIZER - Is a substance that gives up oxygen easily to stimulate combustion of organic material.

PERMISSIBLE EXPOSURE LIMIT (PEL) - An exposure, inhalation or dermal permissible exposure limit specified in 8 CCR 5155. PELs may be either a time-weighted average (TWA) exposure limit (8-hour), a 15-minute short-term limit (STEL), or a ceiling (C).

PERSONAL PROTECTIVE EQUIPMENT - Any devices or clothing worn by the worker to protect against hazards in the environment. Examples are respirators, gloves, and chemical splash goggles.

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PHYSICAL HAZARD - A chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive), or water-reactive.

PYROPHORIC - A chemical that will spontaneously ignite in the air at a temperature of 130°F (54.4°C) or below.

REACTIVITY - A substance's susceptibility to undergoing a chemical reaction or change that may result in dangerous side effects, such as explosion, burning, and corrosive or toxic emissions. The conditions that cause the reaction, such as heat, other chemicals, and dropping, will usually be specified as "Conditions to Avoid" when a chemical's reactivity is discussed on an SDS.

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

RESPIRATOR - A device which is designed to protect the wearer from inhaling harmful contaminants.

RESPIRATORY HAZARD - A particular concentration of an airborne contaminant that, when it enters the body by way of the respiratory system or by being breathed into the lungs, results in some body function impairment.

SELECT CARCINOGENS - Any substance which meets one of the following:

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 ("carcinogen 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.

SENSITIZER - A substance that may cause no reaction in a person during initial exposures, but afterwards, further exposures will cause an allergic response to the substance.

SHORT-TERM EXPOSURE LIMIT - Represented as STEL or TLV-STEL, this is the maximum concentration to which workers can be exposed for a short period of time (15 minutes) for only four times throughout the day with at least one hour between exposures. Also the daily TLV-TWA must not be exceeded.

SOLVENT - A substance, commonly water, but in industry often an organic compound, which dissolves another substance.

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THRESHOLD LIMIT VALUE (TLV) - Airborne concentration of substances devised by the ACGIH that represents conditions under which it is believed that nearly all workers may be exposed day after day with no adverse effect. TLVs are advisory exposure guidelines, not legal standards, that are based on evidence from industrial experience, animal studies, or human studies when they exist. There are three different types of TLVs: Time-Weighted Average (TLV-TWA), Short-Term Exposure Limit (TLV-STEL), and Ceiling (TLV-C). (See also PEL).

TOXICITY - A relative property of a material to exert a poisonous effect on humans or animals and a description of the effect and the conditions or concentration under which the effect takes place.

VAPOR - The gaseous form of substances which are normally in the liquid or solid state (at normal room temperature and pressure). Vapors evaporate into the air from liquids such as solvents. Solvents with lower boiling points will evaporate faster.

¹ Much of the information required for the form can be found on the chemical's safety data sheet (SDS) or container label

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Appendix T: Procedures for Safe Use of Pyrophoric Liquid Reagents

Researchers should not use pyrophoric reagents until they have read and fully understood these safe operating procedures. However, reading these procedures does not substitute for hands-on training. New users of pyrophoric reagents must work under the close supervision of an experienced user.

I. Scope

A variety of liquid reagents are pyrophoric (spontaneously ignite in air) including (but not necessarily limited to):

Alkyllithium reagents (Typically in hydrocarbon solvents) (*Tert*-butyllithium is VERY pyrophoric)
Alkenyllithium and Aryllithium reagents (Typically in hydrocarbon solvents)
Alkyndyllithium reagents (Typically in hydrocarbon solvents)
Grignard Reagents (RMgX) (Typically in hydrocarbon solvents)
Alkylaluminum reagents (Neat or in hydrocarbon solvents) (Neat reagents are VERY pyrophoric)
Alkylzinc reagents (Neat reagents are pyrophoric)
Boranes (Neat reagents are pyrophoric)

II. Hazards

In general these materials are pyrophoric; they ignite spontaneously when exposed to air. They also tend to be associated with flammable solvents. Other common hazards include corrosivity, water reactivity, peroxide formation, toxicity, and damage to the liver, kidneys, and central nervous system.

III. Controlling the Hazards

BEFORE working with pyrophoric reagents, read the relevant Safety data sheets (SDS) and understand the hazards. The SDS must be reviewed before using an unfamiliar chemical and periodically as a reminder.

Set up your work in a laboratory fume hood or glove box and ALWAYS wear the appropriate PPE

Personal Protective Equipment (PPE)

Eye Protection

- Chemical Splash goggles or safety glasses that meet the ANSI Z.87.1 1989 standard must be worn whenever handling pyrophoric chemicals. Ordinary prescription glasses will NOT provide adequate protection unless they also meet this standard. When there is the potential for splashes, goggles must be worn, and when appropriate, a face shield added.
- A face shield is required any time there is a risk of explosion, large splash hazard or a highly exothermic reaction. All manipulations of pyrophoric chemicals which pose this risk should occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants, are acceptable.

Skin Protection

- Gloves must be worn when handling pyrophoric chemicals. Nitrile gloves should be adequate for handling most of these in general laboratory settings but they are combustible. Use adequate protection to prevent skin exposures. Heavy gloves are required for work with large

quantities.

- A fire resistant lab coat must be worn.
- A chemical-resistant apron worn over the lab coat is required for working with large quantities.
- No open toe shoes are allowed.

IV. Designated Work Area

Eyewash

- Suitable facilities for quick drenching or flushing of the eyes should be within 10 seconds travel time for immediate emergency use. Bottle type eyewash stations are not acceptable.

Safety Shower

- A safety or drench shower should be available within 10 seconds travel time where pyrophoric chemicals are used.

Fume Hood

- Many pyrophoric chemicals release noxious or flammable gases and should be handled in a laboratory hood. In addition, some pyrophoric materials are stored under kerosene (or other flammable solvent), therefore the use of a fume hood (or glove box) is required to prevent the release of flammable vapors into the laboratory.

Fire Extinguisher

- A Class C dry chemical fire extinguisher must be available within 10 seconds travel time from where pyrophoric chemicals are used.
- Know the location of the nearest Class D fire extinguisher.
- A container of powdered lime (calcium oxide, CaO) should be kept within arm's length when working with a pyrophoric material.

Glove (dry) box

- Glove boxes are an excellent device to control pyrophoric chemicals when inert or dry atmospheres are required.

V. Protocols

Handling pyrophoric Reagents

By using proper needle and syringe techniques, these reagents can be handled safely in the laboratory.

The Aldrich¹ Sure/Seal™ Packaging System

The Sure/Seal packaging system (**Fig. 1A**) provides a convenient method for storing and dispensing air-sensitive reagents. The reagent can be dispensed using a syringe or double-tipped needle (16, 18 or 20 gauge) inserted through the hole in the metal cap. When inserting a needle through a septum, a layer of silicone or hydrocarbon grease on the septum will help. Upon withdrawal of the needle, the small hole that remains in the PTFE liner will not cause the reagent to deteriorate under normal circumstances. However, it is recommended that the plastic cap be replaced after each use and in particular for long-term storage.

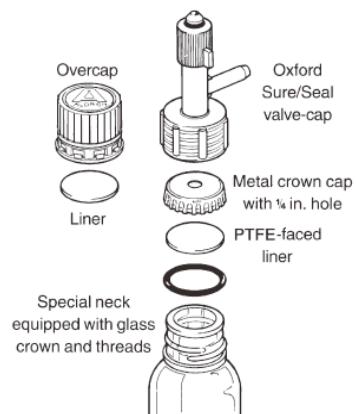


Figure 1A Sure/Seal components

For extended storage of unused reagents, use the solid plastic cap, or equip the bottle with an

Oxford Sure/Seal valve cap, or transfer the reagent to a suitable storage vessel.

The Sure/Seal septum-inlet transfer adapter (**Fig. 1B**) can be used when repeated dispensing is necessary. The adapter protects the contents of the bottles from air and moisture



Fig. 1B Sure/Seal
septum-inlet transfer
adapter

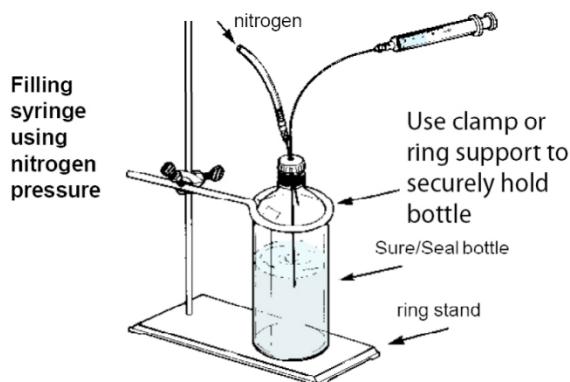


Fig. 2A Filling syringe

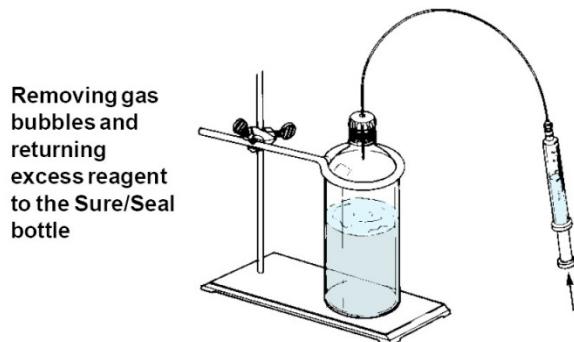


Fig. 2B Removing gas bubbles and returning excess reagent to the Sure/Seal bottle

Transferring Pyrophoric Reagents with Syringe

- Clamp the reagent bottle and receiving vessel to prevent them from moving.
- Insert a needle from an inert gas source with a bubbler outlet into the bottle keeping the needle tip above the liquid level.
- NOTE: The goal of this technique is to equalize the pressure in the reagent bottle. A different technique is to use inert gas pressure to force reagent into the syringe, but that has the danger of blowing the plunger out of the syringe body and spilling out pyrophoric reagent.
- Flush dry syringe with inert gas, depress the plunger and insert the needle into the Sure/Seal bottle.
- NOTE: For large volume syringes, use a corresponding larger gauge needle.
- Gently pull the plunger to draw liquid into the syringe (Fig. 2A). Pulling too hard or too fast can cause air bubbles to enter between the plunger and syringe body.
- NOTES: Simple glass syringes are more prone to causing gas bubbles. Disposable plastic syringes have a good seal on the plunger and work well. Glass syringes with Teflon-tipped plungers (gas- tight) syringes are best. For safest work, do not fill syringe more than 60% full, up to a maximum of 10 mL of liquid. The double-tipped needle technique is safer when transferring 10 mL or more.
- Excess reagent and entrained bubbles are then forced back into the reagent bottle (Fig. 2B).
- FOR HIGHLY PYROPHORIC materials such as *tert*-butyllithium and trimethylaluminum, it is best to draw a plug of inert gas from the headspace into the needle after excess reagent is forced back into the bottle (Fig. 2B) and before withdrawing the needle.
- The desired volume of reagent in the syringe is quickly transferred to the reaction apparatus by puncturing a rubber septum as illustrated in Fig. 2C.

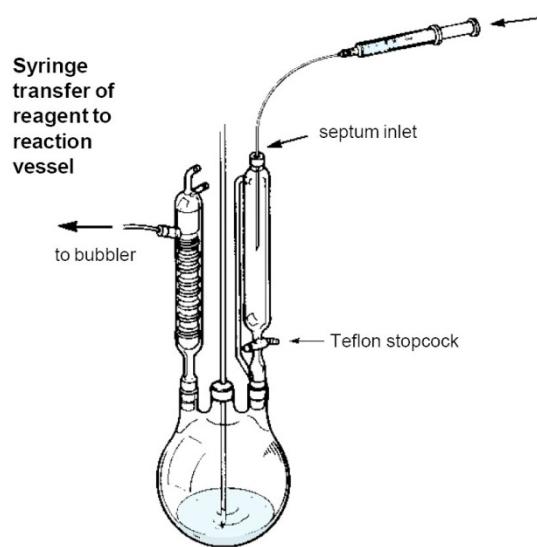


Fig. 2C Syringe transfer of reagent to reaction vessel reagent

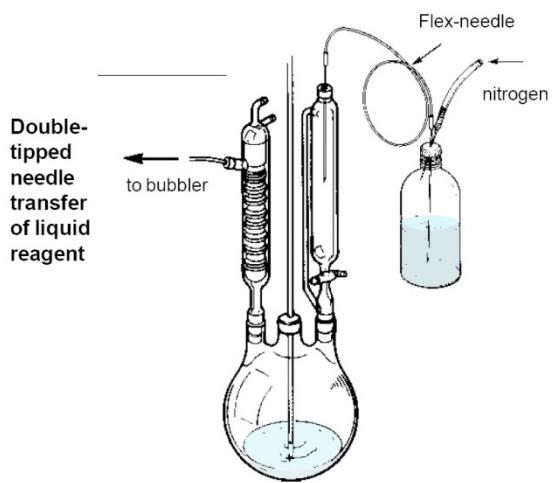


Fig. 3A Double-tipped needle transfer of liquid reagent

Transferring Pyrophoric Reagents with a Double-Tipped Needle

- The double-tipped needle technique is recommended when transferring 10 mL or more.
- Pressurize the Sure/Seal bottle with nitrogen and then insert the double-tipped needle through the septum into the headspace above the reagent. Nitrogen will pass through the needle. Insert the other end through the septum at the calibrated addition funnel on the reaction apparatus which must be equipped with a gas line to a bubbler. Push the needle into the liquid in the Sure/Seal reagent bottle and transfer the desired volume. Then withdraw the needle to above the liquid level. Allow nitrogen to flush the needle. Remove the needle first from the reaction apparatus and then from the reagent bottle. (**Fig. 3A**)
- Alternatively, for an exact measured transfer, convey from the Sure/Seal bottle to a dry nitrogen flushed graduated cylinder fitted with a double-inlet adapter (**Fig. 3B**). Transfer the desired quantity and then remove the needle from the Sure/Seal bottle and insert it through the septum on the reaction apparatus. Apply nitrogen pressure as before and the measured quantity of reagent is added to the reaction flask.
- To control flow rate, fit a Luer lock syringe valve between two long needles as shown in (**Fig. 3C**).

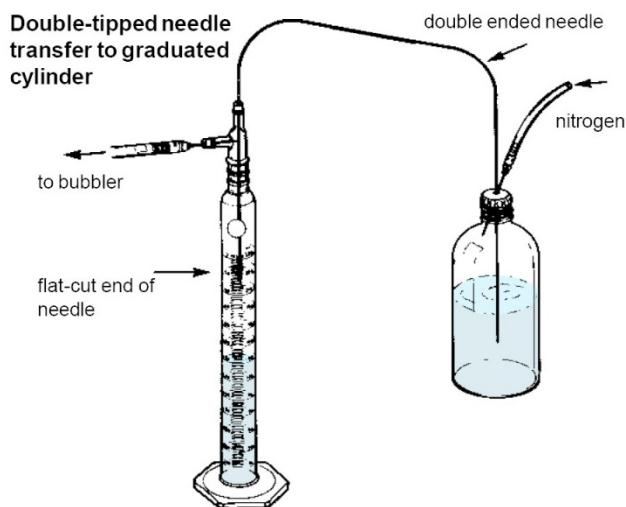


Fig. 3B Double-tipped needle transfer to graduated cylinder

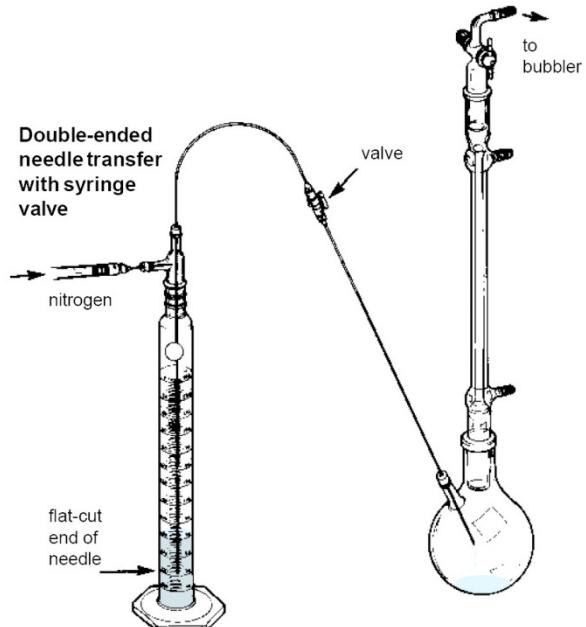


Fig. 3C Double-ended needle transfer with syringe valve

Cleaning Pyrophoric Reagents from Needles and Syringes

- Needles and syringes used with pyrophoric reagents must be cleaned immediately to avoid clogging the needles and seizing the syringes.
- Draw hexane into the syringe containing small amounts of pyrophoric reagent and then discharge the diluted solution into isopropanol.
- Similarly, flush double-tipped needles with hexane and then quench hexane wash in isopropanol.

Storage

- Store pyrophoric chemicals under an inert atmosphere or under kerosene as appropriate.
- Avoid areas with heat/flames, oxidizers, and water sources.
- Containers carrying pyrophoric materials must be clearly labeled with the correct chemical name and hazard warning.

Disposal of Pyrophoric Reagents

- Small amounts of unused or unwanted pyrophoric materials must be destroyed by careful quenching of the residue. Transfer the materials to an appropriate reaction flask for hydrolysis and/or neutralization. Dilute significantly with an unreactive solvent such as heptane or toluene and place the flask in an ice water cooling bath. Slowly add isopropanol to quench pyrophoric materials. Upon completion, add methanol as a more reactive quenching agent to ensure completion. Finally, add water dropwise to make sure there are no pockets of reactive materials. Dispose of as hazardous waste.
- Alternatively, reactive substances can be quenched by slowly adding the dilute solution to dry ice, then adding a mildly reactive quenching agent such as methanol.
- AVOID low boiling diluents such as ether and pentane that tend to condense water upon evaporation.
- Do not leave containers with residues of pyrophoric materials open to the atmosphere due to uncontrolled ignition.

Disposal of Pyrophoric Solid Reagents by Submitting to EHS as Hazardous Waste

- Larger quantities of pyrophoric chemicals can be disposed of as hazardous waste.
- Carefully package and label the wastes.
- **Specifically Alert** EH&S personnel at the collection location to the hazards of any wastes containing pyrophoric chemicals.

VI. Emergency Procedures

Spill - Small

- Exert extreme caution due to potential spontaneous combustion.
- Exert extreme caution due to potential ignition of flammable solvents or other materials.
- If anyone is exposed, or on fire, wash with copious amounts of water, ideally in the lab shower.
- Call for a coworker to provide backup.
- Place a fire extinguisher nearby.
- Carefully remove nearby flammable materials.
- Powdered lime (calcium oxide, CaO) or dry sand should be used to completely smother and cover any spill that occurs.

- Carefully quench by slow addition of isopropanol.
- After complete quench, double bag spill residues for hazardous waste pickup.
- Call 911 for emergency assistance if necessary.

Spill - Large

- Exert extreme caution due to potential spontaneous combustion.
- Exert extreme caution due to potential ignition of flammable solvents or other materials.
- If anyone is exposed, or on fire, wash with copious amounts of water, ideally in the lab shower.
- Call 911 for emergency assistance.
- Evacuate the spill area.
- Post someone or mark-off the hazardous area with tape and warning signs to keep other people from entering.
- Provide emergency personnel with technical advice on the chemicals involved.