UCSB LABORATORY SAFETY MANUAL
and
CHEMICAL HYGIENE PLAN

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Acknowledgements: thanks to the following for their assistance and expertise in compiling this manual:
UCSB Laboratory Safety Division
MANUAL PURPOSE - this manual serves two basic purposes:

1. It is the basic laboratory safety manual for UCSB

2. Serves as the campus Chemical Hygiene Plan (CHP) as required by the California Occupational Safety and Health Administration (Cal-OSHA). In short, OSHA requires that a written chemical safety plan address the policies and procedures that an employer has in place to minimize the exposure of its lab employees to chemicals. Workers are required to receive documented training on their CHP. A full summary of the OSHA standard is in Sec. III.

For lab supervisors, the most important portion of this manual (Section I) contains links to Standard Operating Procedures (SOP) templates for developing their required Lab-specific Chemical Hygiene Plan.

MANUAL STRUCTURE

- **Section I: Introduction and Lab-specific Chemical Hygiene Plan.** Forms and templates for customizing your CHP with SOPs and other local information. Links to other lab safety programs.

- **Section II: UC & UCSB policies, procedures and resources.** Summaries of key/core lab safety issues that apply to most/all laboratories. Primarily based on specific OSHA requirements.

- **Section III: Regulatory Framework.** Overview of the OSHA CHP Standard; specific University policies relative to the Lab Standard; roles and responsibilities of UCSB personnel in the program.

OTHER UCSB RESEARCH SAFETY PROGRAMS / REGULATIONS

Given the breadth of research at UCSB, there are other campus safety programs and regulations that can apply to a given operation. In the interests of keeping this manual shorter, more specialized programs are not directly included herein. Instead, links to these programs are provided below and affected individuals should contact these program managers for further information.

**Injury and Illness Prevention Program**
The “umbrella” OSHA-required worker safety program that applies to all campus workers, regardless of work activities. Elements include: designation of individuals with the authority/responsibility for program (Chairs, Directors, etc.); documented safety training and inspections; injury investigation; safety communication to workers, etc. There is significant overlap between IIPP elements and this manual as relates to lab work, particularly the training and inspection components.

**Biological Safety Program:** Biological Use Authorizations; Aerosol Transmittable Diseases; Bloodborne Pathogens; Medical Waste Management
Section I: Laboratory-specific Chemical Hygiene Plan

Radiation Safety Program:
Oversight of radioactive materials; radiation-producing machines and lasers

Hazard Communication Standard Program
Safety Data Sheets (formerly MSDS); chemical labeling
(for labs, much of the HazCom program is superseded by the CHP program – see SDS pg. in Sec. II)

Research Diving and Boating Safety Program
Oversight of research projects involving SCUBA and small boats

Controlled Substance Program
Oversight of research activities using State/Federal regulated narcotic and non-narcotic drugs

Fire Protection Programs
Includes fire extinguisher training for lab workers, oversight and inspections of fire alarms, sprinklers and other fire protection infrastructure, plus State Fire Marshal approval of plans for lab construction.

Animal Care and Use
Oversight of care and use of animals used in campus research activities

Respiratory Protection Program (see pg. II-9)

Confined Space Program
Campus/OSHA requirements and procedures for entering Permit Required Confined Spaces

Indoor Air Quality Program
Response to concerns regarding IAQ within and around campus buildings, especially as relates to health and comfort of building occupants

Hearing Conservation Program
Personnel exposed to occupational noise levels exceeding an 8-hr time-weighted average of 85 dBA must be enrolled in this UCSB/OSHA program

Heat Illness Program
Establishes campus/OSHA requirements and procedures for individuals who perform outdoor work

Ergonomics Program
Assessments and trainings designed to analyze and evaluate an employee’s workspace, equipment, body mechanics, posture, and work flow to promote a more efficient, productive worker and prevent musculoskeletal injuries.
Table of Contents

Contents

MANUAL DESCRIPTION ................................................................................................................. 2
Table of Contents ............................................................................................................................ 4
Section I: Laboratory-Specific Chemical Hygiene Plan MRL Polymer Facility ......................... 6
Introduction ....................................................................................................................................... 6
Required Training ............................................................................................................................. 7
General Laboratory Information ........................................................................................................ 8
Emergency Information ...................................................................................................................... 8
Health & Safety References .............................................................................................................. 10
General Laboratory and Chemical Safety ......................................................................................... 11
Ten Commandments of Safety ......................................................................................................... 15
Identifying Chemical Hazards ......................................................................................................... 16
Background: Standard Operating Procedures ................................................................................. 17
Standard Operating Procedures: Chloroform .................................................................................... 17
Standard Operating Procedures: Methanol ....................................................................................... 19
Standard Operating Procedures: N,N-DiMethylFormamide .......................................................... 21
Standard Operating Procedures: Methylene Chloride ..................................................................... 23
Standard Operating Procedures: Working with Cryogens ............................................................... 25
Note: Hazards Around You in MRL 1043 and 1050 ..................................................................... 27
Appendix A: Osha Quick Card Reference ....................................................................................... 28
Appendix B: MRL Emergency Operations Plan .............................................................................. 29
Appendix C: EH&S Laboratory Safety Fact Sheets .......................................................................... 35
LABORATORY SAFETY FACT SHEET #37 Safe Use of Pyrophoric/Water Reactive Reagents ........ 36
LABORATORY SAFETY FACT SHEET #7 SAFE STORAGE OF CHEMICALS ................................ 41
LABORATORY SAFETY FACT SHEET #31 HOUSEKEEPING AND CLUTTER IN THE LABORATORY . 44
LABORATORY SAFETY FACT SHEET #32 Be Prepared for Power Failures .................................. 45
LABORATORY SAFETY FACT SHEET #39 Safety Guidelines for Receiving Hazardous Materials Shipments in Non-Lab Areas .......................... 47
Laboratory Safety Fact Sheet #1 Nonstructural Seismic Hazard Reduction Policies ................... 48
Time-Sensitive Chemicals ............................................................................................................... 49
LABORATORY SAFETY FACT SHEET #19 Centrifuge Safety .................................................... 50
LABORATORY SAFETY FACT SHEET #5 Refrigerators & Freezers in Lab ................................. 51
LABORATORY SAFETY FACT SHEET #6 CHEMICAL WASTE DISPOSAL ............................... 52
Appendix D: Laboratory Self-Inspection Checklist ........................................................................ 53
Appendix E: MRL Injury Illness Prevention Plan..........................................................60
Appendix F: Other Resources..................................................................................63
CHEMICAL HYGIENE PLAN: CERTIFICATION PAGE.............................................64
Laboratory Worker Training Record: Chemical Hygiene Plan.................................65
This page left intentionally blank .............................................................................66
SECTION II: .............................................................................................................67
UC/UCSB POLICIES, PROCEDURES AND RESOURCES..............................................67
Emergency Response Procedures ..........................................................................69
Recommended Chemical Spill Cleanup Procedures .................................................70
Fire Extinguishers, First-Aid Kits and Emergency Showers/Eyewashes ..................71
UC Policy on Laboratory Personal Protective Equipment (PPE)..............................72
Other Policy Aspects: ............................................................................................72
UC Policy on Laboratory Safety Training ................................................................77
Exposure Limits for Laboratory Chemicals & Carcinogens ....................................78
Safety Data Sheets (SDS, formerly known as MSDS) .............................................79
(M)SDS Sources: ..................................................................................................79
Chemical Labelling ................................................................................................80
Pictograms and Hazard Codes Used in the Globally Harmonized Chemical Labeling System ........................................................................................................81
Criteria for Implementing Engineering Controls .....................................................82
General Procedures for Working with Hazardous Chemicals and Operations ..........83
  4 Evaluating Hazards and Assessing Risks in the Laboratory .................................83
  5 Management of Chemicals ................................................................................84
  6 Working with Chemicals ....................................................................................84
  7 Working with Laboratory Equipment ...............................................................84
Fume Hood Usage Guide: Standard Hoods ..............................................................85
Refrigerators and Freezers in Labs .........................................................................87
EH&S Laboratory Inspection and Lab Outreach Programs ......................................88
Chemical Waste Disposal ......................................................................................89
  STORAGE ..........................................................................................................89
  LABELING ........................................................................................................89
  DISPOSAL .........................................................................................................89
Laboratory Sharps Disposal ....................................................................................90
  Sharps Disposal Basic Flowchart (see above for specific types of hazmat-contaminated sharps) .................................................................91
This page left intentionally blank ...........................................................................92
Section III: REGULATORY FRAMEWORK .............................................................93
Introduction

Welcome to the MRL Polymer Facility. Everyone working here has to act in a professional, safe, and environmentally responsible fashion otherwise it becomes difficult for anyone to get any work done. Nobody wants to have to clean up someone else’s mess before they can begin work, so everyone needs to take care for the lab. We all need to make sure we all follow the many laws and regulations about safe work practices.

Safety training begins with the EH&S Laboratory Safety class. Everyone working in the lab is required to take this course BEFORE beginning lab work. Most people will need to take the class in person. Additional training builds on the EH&S class. See the section on Required Training.

The second part of the required safety training is this Chemical Hygiene Plan (CHP). Everyone who wishes to work in the Polymer Facility needs to read this Chemical Hygiene Plan. After reading the CHP, people need to document that they have read it. This should be documented by signing a log sheet in my office, MRL 2003.

Please remember that although the work that you may be doing is not particularly hazardous, hazardous procedures may be going on around you. Due to this, we must follow safety guidelines and wear the proper PPE for the environment we are working in.

I try as hard as I can to insure that the lab is fully functional, as user friendly as possible, and as safe as possible. To accomplish this, I need your help. If you see any kind of safety problem, or if we are low or out of some necessary supply, or that some equipment is not working right, please send me e-mail describing the problem. E-mail is the best way to keep me up to date and to help me remember. Please let me know if there is any imminent hazard and any kind of safety problem. Never leave lab supply, personal effect, glassware, books or papers out in the lab except when you are actually using them.

Chemical storage space is very limited. Before purchasing new chemicals please check the laboratory. Besides conserving room, this will save you time and money. If you have reagent that someone else needs please share it with them.

From time to time we have to clean lab. These may occur when the lab has become particularly messy, before an inspection or a tour, or at the end of the summer intern session. Everyone working in the lab should participate. With everyone’s help, we will continue to perform safe and ground breaking research at one of the top materials research facilities in the world.
Sec. I: Laboratory-specific Chemical Hygiene Plan

### Required Training

In order to become an authorized user of the Polymer Facility, the individual must fulfill ALL the requirements listed below:

1. Complete EH&S general laboratory safety training
2. Review MRL general safety documents
3. Be trained to operate the instruments in a safe manner
4. Review the laboratory specific Chemical Hygiene Plan (this document)
5. Document all above steps and submit records to appropriate personnel

Safety training begins with the EH&S Laboratory Safety class. Everyone working in the lab is required to take this course before beginning lab work. The EH&S Lab Safety class is offered In-Person (LS01) twice quarterly and the schedule is posted online at:

http://learningcenter.ucsb.edu

Since most people who need to take the class In-Person also need to begin their lab work as soon as possible, we allow TEMPORARY lab access until the next In-Person class by completing the Online class (LS60), also available at:

http://learningcenter.ucsb.edu

After the EH&S class, people working in the MRL Polymer Lab need to study this handout, to read:
1. MRL Safety Information: http://www.mrl.ucsb.edu/mrl-safety-information
2. The Polymer Laboratory Chemical Hygiene Plan (CHP) paper copy or online. If you have any questions, please contact Dr. Rachel Behrens, MRL 2003, phone: x5850 and e-mail: rachel@mrl.ucsb.edu.
3. To document the completion of this training step, please fill out the form below:
http://www.mrl.ucsb.edu/sites/default/files/mrl_docs/forms/safety_training_form.pdf

Instrument training can be arranged by requesting training through the Facilities Billing Services (FBS: https://ucsb.fbs.io/Anon/Logon.aspx) or by emailing me. This training will cover hands-on training to operate the instruments and introduction to the safety information of the laboratory.

As much as it may seem, all of the above is just the foundation of the laboratory safety training. Everyone working in the lab must do the appropriate inquiry, literature research, and thought to insure that the specific lab work they do is performed safely. The actual preparation will vary depending on what the project will be, but will certainly include studying the chemical hazards of the materials to be used and speaking with people who have done similar work. More work may be necessary, such as reviewing any physical or electrical hazards and considering if specialized personal protective equipment is required. I am available to answer questions and to help, but you ultimately will be the one carrying out the work, so you will need to be familiar with the potential hazards.
Sec. I: Laboratory-specific Chemical Hygiene Plan

### General Laboratory Information

Laboratory Supervisor (PI): Craig Hawker, MRL 3005  
Laboratory Technical Director (TD): Rachel Behrens, MRL 2003, x5850

Laboratory Location(s) (Building /Rooms): MRL 1043, 1050, 1051, and 1052

**Department Information**  
Department Safety:  
Alex Moretto, Laboratory Safety Program Manager, UCSB EH&S, phone: 617.480.6630

Dr. Amanda Strom, MRL 2066F, phone: x7925 (DSR)  
Mike Craig, MRL 2066A, phone: x8990 (DSR)  
Joni Schwartz, MRL 2066E, phone: x8519 (DSR alternate)

Location of Department Safety Bulletin Board: MRL 2042

Location of Building Emergency Assembly Point: South West corner of Engineering II.

### Emergency Information

As applicable, please provide information regarding emergency procedures and equipment specific to the lab(s) under your control. Where applicable you may just reference the emergency contact information on your lab door placards.

- **Evacuation procedures** (e.g., close fire doors, secure certain equipment, etc.)  
  Leave the room and the building as quickly as possible. Proceed to the Emergency Assembly area which is north of the MRL Building at the south west corner of Eng. II. If time take valuable personal property.

**Earthquake**

During an earthquake, you should try to stand in a doorframe until all shaking has stopped and only then evacuate the building. Another option is to seek shelter under a desk.

**Fire**

If a fire alarm goes off you must leave the building and proceed to the Emergency assembly location (SW corner of Eng II). **Do not use the elevators.**

For reporting a fire, fire alarm pull stations are located on the walls of the main hallways. Per SB County Fire and UCSB campus policy, all fires must be reported to 9-911 immediately even if the fire is out. If a fire extinguisher is used it must be reported as it will need to be replaced.

- **First-aid kit** (e.g., location, contents, maintenance responsibility, etc.) First-aid kits are located in each lab:  
  MRL 1043: On top of the refrigerator by the exit
Sec. I:  Laboratory-specific Chemical Hygiene Plan

MRL 1050: Two are located near the exit
MRL 1051 and 1052: Please use the resources in MRL 1043 or 1050
It is responsibility of the Lab TD to maintain the first aid kits.

In the Event of an Injury
Per campus policy, all significant injuries must be documented with “Create a Claim” by completing an Employee First Report (EFR). This is necessary for potential reimbursement for personal medical costs, or Worker’s Compensation Claims. For directions on how to create a claim, visit: 
http://www.ehs.ucsb.edu/files/docs/wc/EFRCreateAClaim.pdf

Serious Injuries
If the situation is immediately threatening to life or limb, get emergency care, e.g. by calling 9-911 from any campus phone. This is preferred to taking an injured person directly to the Goleta Valley Cottage Hospital Emergency Room or Sansum Occupation Medical Clinic, where they may not be seen or treated for a long time if they don’t arrive in an ambulance.

Other Injuries
Students – For serious injuries not threatening to life or limb, undergraduates and graduate students who are not "employed" by UCSB, may be treated at Student Health Services. http://studenthealth.sa.ucsb.edu/contact-us/directions

UCSB Employees – Staff, Faculty, Graduate Student employees, undergraduate employees, Post Doc, and other UCSB employees with serious work related injuries, which are not threatening to life or limb, should use an Urgent Care Facility (that UC has contracted with, such as Goleta Valley Cottage Hospital Emergency Room or Sansum Occupation Medical Clinic) for walk-in treatment.

- Spill cleanup materials (e.g., location, contents, maintenance, procedures, etc.)
  Chemical spill cleanup kits are kept in 1043 MRL on top of the refrigerator and in 1050 MRL under the cabinet.

- Laboratory monitors or alarms (e.g., operation, response, maintenance, etc.)
  There is an oxygen level monitor in MRL 1050. This is maintained by the technical director.

  There are no other lab monitors except for low air flow monitors on the fume hoods. These are to be maintained by campus Physical Facilities.

- Other Lab-specific emergency information
  The MRL Emergency Operations Plan (see also appendix A): http://www.mrl.ucsb.edu/mrl-emergency-operations-plan
Sec. I: Laboratory-specific Chemical Hygiene Plan

Per campus policy, all significant injuries must be documented via the Employee’s First Report (EFR) located at [http://ehs.ucop.edu/efr](http://ehs.ucop.edu/efr) as soon as possible. This is necessary for potential reimbursement for personal medical costs, or Worker’s Compensation Claims, or in serious cases reporting to Cal-OSHA.

Per SB County Fire and campus policy, all fires must be reported to 9-911 immediately — even if the fire is out. This is particularly true if there is use of an extinguisher (must be replaced); an injury; or property damage.

### Health & Safety References

Please list here the title and location of health and safety reference materials (reference books¹, Safety Data Sheets², experimental protocols, etc.) associated with the lab which employees may use to aid them in their work.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Location</th>
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<tbody>
<tr>
<td>1. Laboratory Safety Program/Chemical Hygiene Plan</td>
<td>1043, 1050 MRL</td>
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<tr>
<td>2. Paper Copies of (M)SDS</td>
<td>1043, 1050 MRL</td>
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<tr>
<td>3. Electronic Copies of select (M)SDS computers in 1043, 1050, 1052, and 1053 MRL</td>
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<tr>
<td>4. Merck Index</td>
<td>2003 MRL</td>
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<tr>
<td>5. Handbook of Chemistry and Physics</td>
<td>2003 MRL</td>
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1-The book entitled: *Prudent Practices in the Laboratory* by the National Research Council is widely considered to be a definitive reference. It can be purchased, but is also available free on-line in a searchable format. It is recommended that all lab workers have ready access to this important reference.

Safety Data Sheets (formerly known as MSDS). Per OSHA, all lab users must know:

a) what an SDS is,
b) SDS relevance to their health and safety,
c) how to readily access them*

These issues are all covered in the EH&S lab safety orientation program.

* Labs are encouraged to maintain hard copies of their own MSDS for the hazardous chemicals they routinely use, or at minimum, have this link bookmarked by all individuals in the lab.
Sec. I: Laboratory-specific Chemical Hygiene Plan

General Laboratory and Chemical Safety

In addition to the guidelines provided below, it is recommended that you go over the Laboratory Safety Self-Checklist in Appendix E. This document is also available on the web at: http://www.ehs.ucsb.edu/files/docs/ls/Lab_Self_InspectionChecklist_web_August_2016.pdf

General
- No storage of food and drinks in the MRL labs 1043, 1050, 1051, and 1052 which has an extensive list of chemicals.
- Smoking is prohibited anywhere in the lab.
- Do not block lab aisles with chairs, stools, or equipment.
- Observe all posted signs and instructions.

Electrical Safety
- Do not use damaged electrical cords. Do not chain extension cords/power strips.
- Do not leave extension outlets or power strips on the floor where it may be flooded.

Gas cylinder handling
- All gas cylinders need to be secured with welded link metal chain so they do not fall over in an earthquake.
- When moving a gas cylinder, place the safety cap over the valve before undoing the chain securing the cylinder.
- Use the special dolly for gas cylinders that is kept in the MRL gas cage (across the little parking lot on the ocean side of the building).

Chemical Safety
- For transport of larger (> 1 L) glass bottles with chemicals, use designated carriers or plastic buckets.
- Keep chemicals stored in the appropriate cabinets or designated storage rooms when not in use (NOT IN FUME HOODS). Only obtain an amount to keep your test or research going, like a one day/week supply. This will free up lab bench space and, if you do have a spill it will minimize the amount of chemical released.
- Put away all reagents, samples, and personal materials.
- Keep the lids on chemical containers. This sounds obvious but it will effectively reduce the possibility of a spill and reduce any fumes released into your lab and it’s the law.
- Label all containers. Make sure there are no unidentified containers; reagents, samples, drying papers with sample, or crucibles/boats with samples. Label all material by chemical name (Not just initials or formulas).

Cleaning the lab
- Properly dispose of old or unwanted chemicals or any unnecessary items.
- Damp wipe all bench-tops until clean and in particular areas near weighing stations.
- Clean up inside fume hoods.
Sec. I: Laboratory-specific Chemical Hygiene Plan

- Look inside all cabinets for leftover waste and any storage hazards.
- Dispose broken glass trash and “sharp” bins into dumpster outside the building.
- Recycle paper and cardboard properly removed.
- Unused or spare equipment should be stored in a designated storage room/area.
- Equipment or furniture should not block walkways, electrical panels, or emergency eyewash or showers.
- Check emergency egress path is maintained (minimum exit pathway in rooms is 28 inches).
- Verify the lab(s) are clean, organized and anything else required to make lab look professional.
- Check for trip and slip hazards (oil leaks from pumps, electrical cords or hoses across walking path).

Fume Hoods
- Always work with the sash at the level of the arrow stocker and close when not used. Your hood should be producing a face velocity of 100-120 ft/min. EH&S tests your hood and posts the arrow tickers at the proper sash level.
- Many newer hoods are equipped with the airflow monitor and alarm to warn you if the air velocity is too low. If the alarm engages, lower the sash slightly until the alarm stops. If your alarm sounds consistently this indicates a real problem- call Amanda Strom (ext. 7925) or EH&S (805-893-4899).
- Store the bare minimum of equipment and chemicals in your hood. Excess materials will block the air flow and reduce performance significantly.
- Chemicals should not be stored in the fume hood- most fires and explosions occur in the hood during chemical manipulations.
- Keep the lab windows and doors closed. Draft from open windows and doors can significantly affect your hood’s performance.

Disposal of Sharps
- Lab glassware not contaminated by hazardous materials (eq. Pasteur pipettes) place glass into labeled “Sharps Only” trash box or other sturdy container. When full, dispose of contents into the trash dumpster for your building.
- Sharps contaminated with chemicals should be placed into a sharps container and labeled as “Sharps contaminated with (chemical name)” and send to EH&S for disposal. (See Appendix C: Laboratory Sharps Disposal)

Chemical Waste Disposal
- Hazardous waste regulations are stringent and penalties for violations can be severe. Santa Barbara County inspects UCSB labs for compliance on a regular basis.
- Store chemical waste in a designated area. Label area as, “Hazardous Waste Storage Area”.
- Store chemicals in containers compatible with, and durable enough for, the waste. Liquid must be in screw top containers. Do not overfill container, allow for expansion.
- Labeling- identify waste by proper chemical name.
- Deface existing labels when reusing containers.
- Label and date containers when the first drop of waste is added. Hazardous waste shall be disposed within 9 months. Labels are available in all science storerooms.
- Chemicals may not be disposed in a regular trash, sink disposal, or allowed to evaporate. (See Appendix C: Chemical Waste Disposal)
Sec. I: Laboratory-specific Chemical Hygiene Plan

Chemical Spills
• Clean up a spill using the proper equipment (please use spill kit contents- available in 1043 and 1050 MRL).
• Cal EH&S 24-hour line 805-893-3194 if necessary.

Safe storage of chemicals
• In earthquake-prone areas like Santa Barbara, it is particularly vital that chemicals be stored safely. Use a secondary container (plastic tub) large enough to contain a spill of the largest container.
• Store or waste using the following criteria: Flammables, Corrosives, Oxidizers, Carcinogens, Water reactive, Toxics, Pyrophorics. (Globally Harmonized System (GHS) Pictograms and their meanings can be found in Appendix A)
• Acids- store bottles in the acid cabinets, segregate oxidizing acids from organic acids, and flammable materials.
• Segregate acids from bases, and from active metals such as sodium, etc.
• Segregate acids from chemicals which could generate toxic gases such as sodium cyanide, etc.
• Flammable store in approved storage cabinet. Keep away from any source of ignition (flame, heat or sparks).
• Oxidizers-react violently with organics. Keep away fromflammables, from reducing agents, store in a cool, dry place.
• Pyrophoric substances-(spontaneously ignite in air). Some organo-aluminum compounds, silane, divided metals, phosphorus yellow. Rigorously exclude air and water from container. Store away fromflammables, store in a cool dry place.

Refrigerators and Freezers
There are two fridges/freezers in the lab (MRL 1043 and 1050). They are designed for the storage of flammables but are not owned by the Polymer Facilities, so chemical storage for Polymer Facility users should be done so in their own lab space.

_No food or drink must be stored in any of the fridges in the lab._

Minimize the time that this freezer is opened, as moisture from the air rapidly condenses on it.

Personal Protective Equipment (PPE)
Closed-Toe Footwear
• Closed-toe footwear must be worn in the lab at all times!

Lab coats
Laboratory coats are required to be worn while working on, or adjacent to, all hazardous chemicals, biological or unsealed radiological materials. It is imperative to consider the nature of the work performed when choosing a lab coat. In general, you must wear a flame-resistant (blue) lab coat when working in the Main MRL Labs, including MRL 1043 and 1050.
• Note that “standard” lab coats are typically made from a polyester/cotton mix and are not suitable for work with flammables.
• Laboratory coats must not be worn outside of a laboratory unless the individual is traveling directly to an adjacent laboratory work area.
• Each person should have their personal lab coat, which they will receive as part of the PPE provided by UCSB to new lab workers. These laboratory coats must be appropriately sized for the individual and be buttoned to their full length. Laboratory coat sleeves must be of a sufficient length to
Sec. I:  Laboratory-specific Chemical Hygiene Plan

prevent skin exposure while wearing  gloves.

• Lab coats must not be cleaned at home nor in public laundry facilities. Rather, a professional cleaning service must be used. See the information at the lab coat laundering drop off station in the MRL (near the restrooms on the first floor). Any clothing that becomes contaminated with hazardous materials must be decontaminated before it leaves the laboratory. If a lab coat is very heavily contaminated, it should be packaged safely and disposed of as hazardous waste.

Gloves

• Protective gloves must be worn while utilizing any hazardous chemical, biological or unsealed radiological material. These gloves must be appropriate for the material being used and conditions under which such use takes place (e.g., extreme cold).

• Educate yourself as to which chemicals the gloves you are using are resistant and (im)permeable to. You may be unpleasantly surprised. However, there is a tradeoff between chemical resistance of gloves and the dexterity they allow. The increased dexterity offered by thinner gloves may offset their poorer chemical resistance. After all, it is safest not to spill anything in the first place! The latex or nitrile (purple) single-use examination gloves readily available in our lab are a good choice for most powders and for aqueous solutions, as well as simple alcohols (such as methanol, ethanol, and isopropanol) and diethyl ether.

• EH&S has a page with information on gloves, including links to several reference charts with compiled data on chemical resistance of lab gloves at:

  http://ehs.ucsb.edu/units/labsfty/labrsc/lsglove.htm

Spills and Exposure to Hazardous Chemicals

For all incidents in which injury has occurred or may be imminent, follow these steps: Emergency procedure

• Administer First Aid as needed
• Warn people in the area
• Evacuate the area if needed
• Notify 9-911
• Notify Rachel Behrens as soon as feasible

Exposure to Chemicals First Aid

If a chemical splashes in someone’s eye, rinse with copious amounts of water for a minimum of 5 minutes. Small burns or splashes with corrosive chemicals on the skin are also flushed with water for five minutes. Use the emergency showers if a person’s hair or clothing has caught fire (rolling the person on the floor is another option for extinguishing flames) or in the event of a larger spill of a hazardous chemical on skin or clothing.

Some Best Lab Practices

These make the lab a better place to work for everybody:

• Put your reagents back in the proper storage location at the end of every workday
• Refill squirt bottles when they are nearly empty
• Get new solvent bottles from the storeroom before running out
• Label all your bottles/flasks with proper chemical names. Preferably use pencil on tags, not a marker
Sec. I: Laboratory-specific Chemical Hygiene Plan

- Label all running reactions, especially reactions running overnight
- Scales/Scale areas: Keep the scale and surrounding area clean. After weighing, take all your stuff with you, and completely clean up any spills you made. Put a note on the scale if you need the tare to remain set; only do this if you will return after a short time (< 15 minutes), else record the tare weight.
- Close the regulator on gas tanks once you are done using them
- Don’t leave samples, lab supply, personal effects, glassware, books or papers out in the lab except when you are actually using them
- Wash and put away your glassware everyday
- Before purchasing new chemicals be sure to check if any of the required reagents are available in the lab

Leaving Lab
On completion of your work in the Polymer Facility you will need make a way for next person and put your gear back into circulation. Be sure to do following:
- Let me know when you are leaving a few weeks before you leave.
- Dispose any samples that do not need to be archived. Transfer your samples to your supervisor labs.
- Empty out all drawers which you have been using. Any equipment and glassware that has been assigned to you should be back into circulation.
- Any hazardous/chemical waste you have should be labeled and then placed into the waste chemical area.
- Any reagents in your possession should go back to someone in your group.
- Return keys to Sylvia Vogel (MRL 2066G). Let Rachel Behrens know how to reach you.

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<tr>
<th>Ten Commandments of Safety</th>
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<tbody>
<tr>
<td>Thou shalt wear thy safety glasses, as with all other personal protective equipment that shall be required.</td>
</tr>
<tr>
<td>Thou shalt chain all of thy gas cylinders securely with chain of welded link. When the earth shall shake, thy chemicals, bookshelves, and heavy goods must not fall down to the earth or upon thy head.</td>
</tr>
<tr>
<td>Thou shalt not store thy chemicals alphabetically, but only compatibles upon compatibles.</td>
</tr>
<tr>
<td>Thou shalt not smoke within the laboratory. Neither shall thou confuse the laboratory with a place of nourishment.</td>
</tr>
<tr>
<td>Thou shalt never dump thy waste chemicals into the drain. Neither shall thou place any sharp waste, including broken glass, razor blades, nor needles, in the regular trash cans inside the laboratory. Thou shalt place all sharp waste into the dumpster or a special container.</td>
</tr>
<tr>
<td>Thou shalt label all of thy chemicals and samples with thy name and the date. Thou shalt never leave unknown and unmarked bottles of chemicals or samples for thy neighbor.</td>
</tr>
<tr>
<td>Thou shalt purchase only the minimum chemicals for thy needs. Thou shalt covet thy neighbor’s chemicals and thou shalt share thy chemicals with thy neighbor.</td>
</tr>
<tr>
<td>Thou shalt not have multiple extension cords in series.</td>
</tr>
<tr>
<td>Thou shalt not deliver oxygen in plastic tubing, lest the fires of Hell visit upon thy experiment.</td>
</tr>
<tr>
<td>Thou shalt know what thou are doing and about the hazards thou facest. Thou shalt never toil in the laboratory until thou hast studied and trained about safe work practices.</td>
</tr>
</tbody>
</table>
Every lab worker has the responsibility to learn about and understand the hazards of the chemicals they use before starting to use those chemicals. Do not assume that a material is harmless just because you haven’t heard otherwise. Many chemicals are harmful, and some chemicals are mostly harmless by themselves but very dangerous in combination with certain other chemicals.

Besides talking to other people in the lab that use these materials (but don’t assume that they have done their homework, even if they are senior to you!!), these are some resources:

- **Safety Data Sheets (SDS)**. Widely available online (see the Resources section of this CHP), they are especially useful for mixtures, but also for reagents. SDS were intended to be a one-stop source of chemical hazard information, but they frequently are not very specific, not as succinct as one would like, and make everything sound extremely hazardous because they err on the side of caution e.g. for personal protective measures.
- **Laboratory Chemical Safety Summaries (LCSS)** are available for far fewer compounds, but more succinct and useful. Sources for LCSS are on the MRL Safety webpage (see the Resources section of this CHP).
- The **Merck Index** is a compendium that has relevant information for many common chemicals. A copy of the Merck Index is kept in room 2003.
- see also the Resources section of this CHP

Communicating Safety and other Lab Issues
You should report any procedure, condition or situation that you consider to be unsafe, or potentially unsafe. Except for an actual emergency, the best way to communicate a safety problem is to write an email to Rachel Behrens (or Amanda Strom), depending on the nature of the problem. Forms for anonymously reporting a hazardous condition or practice (Hazard reporting forms) are available at the MRL Safety Corner bulletin board in room 2042 if you feel that reporting the hazard in the usual manner would jeopardize you in some way. If supplies are missing, a hazardous waste pickup needs to be arranged, or a piece of equipment is not working, contact Rachel Behrens.
Sec. I: Laboratory-specific Chemical Hygiene Plan

Background: Standard Operating Procedures

Per the Cal-OSHA Standard, a complete CHP includes Standard Operating Procedures (SOP) to aid workers in minimizing chemical exposures in the lab. This is generally interpreted to mean SOPs for the following - not for all possible chemical operations:

- Operations involving what Cal-OSHA specifically designates as Particularly Hazardous Substances (PHS), namely, “Select” Carcinogens, Highly acute toxins, Reproductive toxins
- Other “high-hazard” chemical operations

However, these information sources are very general and can’t cover all operations. Therefore, it is the responsibility of lab supervisors to develop new SOPs (or augment the generic PHS SOP) if needed to protect their workers. The decision on whether a specific SOP is required is the prerogative, but also the responsibility, of the lab supervisor.

Standard Operating Procedures: Chloroform

CHLOROFORM
Type of SOP: □ Process   ☑ Hazardous Chemical   □ Hazard Class

HAZARD OVERVIEW
Chloroform:
- Select carcinogen
- Irritating to skin, eyes and respiratory system

Chloroform (also known as trichloromethane or methylidyne trichloride) is clear colorless liquid, which an acutely toxic chemical. May be harmful if swallowed. May be harmful if inhaled. Irritating to eyes and respiratory system. The product may be absorbed through the skin. May cause irritation of the gastrointestinal tract. May irritate skin. Repeated exposure may cause skin dryness or cracking. Contains material which may cause cancer based on animal data. Use of alcoholic beverages may enhance toxic effects.

EXPOSURE LIMITS
Cal-OSHA has established maximum inhalation exposure limits for workers in occupational settings for over 500 chemicals. These are known as Permissible Exposure Limits and cannot legally be exceeded. For chloroform, the PEL is quite low:

Chloroform: 2 ppm - 8 hour time-weighted average exposure

Therefore, work with these should always be done in a fume hood, glove box, or in totally-sealed containers to keep inhalation exposures as low as possible. Contact EH&S if you believe you are being exposed. In some instances EH&S can do quantitative exposure monitoring.

PERSONAL PROTECTIVE EQUIPMENT (PPE)
See the PPE information under Sec. II of the UCSB Chemical Hygiene Plan regarding:
Sec. I: Laboratory-specific Chemical Hygiene Plan

- the UC PPE Policy and policy summary (what PPE is needed and when/where to use)
- obtaining your PPE via use of the Laboratory Hazard Assessment Tool
- glove selection criteria
- respirator use, etc.

Viton or silvershield gloves are recommended.

ENGINEERING/VENTILATION CONTROLS
For further information see the following pages in Sec. II of the UCSB Chemical Hygiene Plan:
- Fume Hood Usage Guide
- Criteria for Implementing Engineering Controls

Should always be used in fume hood, glove box, or in totally-sealed containers.

SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS
- DO not breathe vapor. Do not get in eyes, on skin or on clothing. Avoid all exposure.

SPILL AND INCIDENT PROCEDURES
See directions under the “Medical Emergency” “Chemical Incident” tabs of the UCSB Emergency Information Flipchart – should already be posted in all labs.

In case of eye or skin contact
Use emergency eyewash and/or shower immediately. Call 9-911 from a campus phone to get immediate emergency medical attention. Continue flushing eyes until emergency responders arrive.

DECONTAMINATION
Using proper personal protective equipment as outlined above, decontaminate equipment and bench tops using soap and water and properly dispose of all chemical and contaminated disposables as hazardous waste following the guidelines below.

WASTE DISPOSAL
See “Chemical Waste Disposal” in Sec. II of the UCSB Chemical Hygiene Plan.

PRIOR APPROVAL/REVIEW REQUIRED
Anyone working for the first time with chloroform in this laboratory must consult with Rachel Behrens.

Users must study the relevant safety information and be aware of the appropriate waste disposal method (via halogenated solvent waste).

DESIGNATED AREA
Chloroform usage should be limited to the GPC sample prep area in MRL 1043, and by the APC and GPC MALS in MRL 1043.

SAFETY DATA SHEETS
Found online at: http://ehs.ucsb.edu/labsafety/msds

LAB-SPECIFIC INFORMATION (required) (Examples of appropriate content)
Chloroform is a solvent used for dissolving polymers. It is used as a solvent in the gel permeation chromatography instrument at room temperature and in small quantities (2 mL or less) for dissolving polymers.
Methanol

Type of SOP:  □ Process  ☑ Hazardous Chemical  □ Hazard Class

HAZARD OVERVIEW
Methanol:
• Methanol is highly flammable and an acute toxin.
• Very harmful in case of skin contact, eye contact, ingestion, or inhalation.

Methanol (also known as methyl alcohol) is a clear colorless liquid. Flammable. In use, may form flammable/explosive vapor-air mixture. May be fatal if swallowed. May be fatal if inhaled. May be harmful if absorbed through skin. Irritating to eyes, respiratory and se blindness. May cause irritation of the gastrointestinal tract. Can be absorbed through skin. Repeated exposure may cause skin dryness or cracking. This product may cause adverse reproductive effects. Possible risk of harm to the unborn child.

EXPOSURE LIMITS
Cal-OSHA has established maximum inhalation exposure limits for workers in occupational settings for over 500 chemicals. These are known as Permissible Exposure Limits and cannot legally be exceeded.

Methanol:  200 ppm - 8 hour time-weighted average exposure

Therefore, work with these should always be done in a fume hood, glove box, or in totally-sealed containers to keep inhalation exposures as low as possible. Contact EH&S if you believe you are being exposed. In some instances EH&S can do quantitative exposure monitoring.

PERSONAL PROTECTIVE EQUIPMENT (PPE)
See the PPE information under Sec. II of the UCSB Chemical Hygiene Plan regarding:
• the UC PPE Policy and policy summary (what PPE is needed and when/where to use)
• obtaining your PPE via use of the Laboratory Hazard Assessment Tool
• glove selection criteria
• respirator use, etc.
Nitrile gloves are recommended.

ENGINEERING/VENTILATION CONTROLS
For further information see the following pages in Sec. II of the UCSB Chemical Hygiene Plan:
• Fume Hood Usage Guide
• Criteria for Implementing Engineering Controls
Should always be used in fume hood, glove box, or in totally-sealed containers.

SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS
• DO not breathe vapor. Do not get in eyes, on skin or on clothing. Avoid all exposure.

SPILL AND INCIDENT PROCEDURES
See directions under the “Medical Emergency” “Chemical Incident” tabs of the UCSB Emergency Information Flipchart – should already be posted in all labs.
Sec. I: Laboratory-specific Chemical Hygiene Plan

In case of eye or skin contact
Use emergency eyewash and/or shower immediately. Call 9-911 from a campus phone to get immediate emergency medical attention. Continue flushing eyes until emergency responders arrive.

DECONTAMINATION
Using proper personal protective equipment as outlined above, decontaminate equipment and bench tops using soap and water and properly dispose of all chemical and contaminated disposables as hazardous waste following the guidelines below.

WASTE DISPOSAL
See “Chemical Waste Disposal” in Sec. II of the UCSB Chemical Hygiene Plan.

PRIOR APPROVAL/REVIEW REQUIRED
Anyone working for the first time with methanol in this laboratory must consult with Rachel Behrens. Users must study the relevant safety information and be aware of the appropriate waste disposal method.

DESIGNATED AREA
Methanol usage should be limited to the GPC sample prep area in MRL 1043, and by the APC, DMF, and GPC MALS in MRL 1043.

SAFETY DATA SHEETS
Found online at: http://ehs.ucsb.edu/labsafety/msds

LAB-SPECIFIC INFORMATION
Methanol is a solvent used as an instrument cleaning agent. It is used as a solvent in the gel permeation chromatography instrument at room temperature and in small quantities.
Sec. I: Laboratory-specific Chemical Hygiene Plan

N,N-dimethylformamide

Type of SOP: ☑ Process ☑ Hazardous Chemical ☑ Hazard Class

HAZARD OVERVIEW
N,N-dimethylformamide (DMF):
• DMF is highly flammable and an acute toxin.
• Very harmful in case of skin contact, eye contact, ingestion, or inhalation.

N,N-Dimethylformamide (DMF) is a common solvent used in organic synthesis and solid phase peptide synthesis. In addition to being flammable, it is associated with a number of serious problems due to chronic exposure. DMF is a reproductive toxin, a known human carcinogen, and attacks the liver and central nervous system. It is harmful through inhalation or skin contact and is ready absorbed through the skin.

EXPOSURE LIMITS
Cal-OSHA has established maximum inhalation exposure limits for workers in occupational settings for over 500 chemicals. These are known as Permissible Exposure Limits and cannot legally be exceeded.

N,N-Dimethylformamide: 10 ppm - 8 hour time-weighted average exposure

Therefore, work with these should always be done in a fume hood, glove box, or in totally-sealed containers to keep inhalation exposures as low as possible. Contact EH&S if you believe you are being exposed. In some instances EH&S can do quantitative exposure monitoring.

PERSONAL PROTECTIVE EQUIPMENT (PPE)
See the PPE information under Sec. II of the UCSB Chemical Hygiene Plan regarding:
• the UC PPE Policy and policy summary (what PPE is needed and when/where to use)
• obtaining your PPE via use of the Laboratory Hazard Assessment Tool
• glove selection criteria
• respirator use, etc.
Neoprene and rubber gloves are recommended.

ENGINEERING/VENTILATION CONTROLS
For further information see the following pages in Sec. II of the UCSB Chemical Hygiene Plan:
• Fume Hood Usage Guide
• Criteria for Implementing Engineering Controls
Should always be used in fume hood, glove box, or in totally-sealed containers.

SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS
• DO not breathe vapor. Do not get in eyes, on skin or on clothing. Avoid all exposure.

SPILL AND INCIDENT PROCEDURES
See directions under the “Medical Emergency” “Chemical Incident” tabs of the UCSB Emergency Information Flipchart – should already be posted in all labs.

In case of eye or skin contact
Sec. I: Laboratory-specific Chemical Hygiene Plan

Use emergency eyewash and/or shower immediately. Call 9-911 from a campus phone to get immediate emergency medical attention. Continue flushing eyes until emergency responders arrive.

DECONTAMINATION
Using proper personal protective equipment as outlined above, decontaminate equipment and bench tops using soap and water and properly dispose of all chemical and contaminated disposables as hazardous waste following the guidelines below.

WASTE DISPOSAL
See “Chemical Waste Disposal” in Sec. II of the UCSB Chemical Hygiene Plan.

PRIOR APPROVAL/REVIEW REQUIRED
Anyone working for the first time with N,N-dimethlyformamide in this laboratory must consult with Rachel Behrens. Users must study the relevant safety information and be aware of the appropriate waste disposal method.

DESIGNATED AREA
N,N-dimethlyformamide usage should be limited to the GPC sample prep area in MRL 1043, and by the DMF GPC in MRL 1043.

SAFETY DATA SHEETS
Found online at: http://ehs.ucsb.edu/labsafety/msds

LAB-SPECIFIC INFORMATION
DMF is a solvent used for dissolving polymers. It is used as a solvent in the gel permeation chromatography instrument at room temperature and in small quantities (2 mL or less) for dissolving polymers.
Methylene Chloride

Type of SOP:  ☑ Process  ☑ Hazardous Chemical  ☐ Hazard Class

For more information, consult a Safety Data Sheet for this material.

Usage

Methylene chloride, also known as dichloromethane (DCM) is commonly used as a reaction solvent, a solvent for extractions in isolating organic compounds, and as an eluent for flash and thin-layer chromatography.

Hazard Overview

Acute Effects: Hazardous in case of eye contact (irritant), of ingestion, of inhalation. In case of ingestion, DCM may cause irritation of the gastrointestinal tract with vomiting. If vomiting results in aspiration, chemical pneumonia could follow. Absorption through gastrointestinal tract may produce symptoms of central nervous system depression ranging from light headedness to unconsciousness. Hazardous in case of skin contact (irritant, permeator). Inflammation of the eye is characterized by redness, watering, and itching. Eye contact may cause temporal eye damage.

Chronic Effects: Can cause headache, mental confusion, depression, liver effects, kidney effects, bronchitis, loss of appetite, nausea, lack of balance, and visual disturbances. Can cause dermatitis upon prolonged skin contact.

Mutagenic Effects: Methylene chloride may cause cancer in humans.

Developmental Toxicity: The substance is toxic to lungs, the nervous system, liver, mucous membrane

Due to its carcinogenicity and toxicity, DCM is specifically regulated by Cal-OSHA. It has designated Permissible Exposure Limits via inhalation which cannot legally be exceeded in the workplace:

- Permissible Exposure Limit (inhalation): 25 ppm (8 hr time weighted average)
- Short-term Exposure Limit (inhalation): 125 ppm (15 minutes)
- Action Level (inhalation): 12.5 ppm

Therefore, given its volatility, it should always be used in a fume hood, glove box, or sealed containers.

Personal Protective Equipment (PPE)

See the PPE information under Sec. II of the UCSB Chemical Hygiene Plan regarding:
- the UC PPE Policy and policy summary (what PPE is needed and when/where to use)
- obtaining your free PPE via use of the Laboratory Hazard Assessment Tool
- glove selection criteria
- respirator use, etc.
Sec. I: Laboratory-specific Chemical Hygiene Plan

Gloves – the most common gloves found in campus labs/storerooms (nitrile, neoprene and latex) are not recommended for use with DCM due to the ease with which it permeates through the glove material. The recommended gloves are “Silver Shield”, polyvinyl alcohol, Viton, or “Barrier” (available from vendors like Fisher Scientific). Some of these gloves have poor dexterity characteristics, but their utility can be increased by wearing a more dexterous glove over the inner glove.

Engineering Controls
All operations involving DCM should be carried out in a certified chemical fume hood to keep airborne level below recommended exposure limits.

For further information on engineering controls see the following pages in Sec. II of the UCSB Chemical Hygiene Plan:
- UCSB Fume Hood Usage Guides
- Criteria for Implementing Engineering Controls

Spill and Incident Procedures
See directions under the “Chemical Incident” and “Medical Emergency” tabs of the UCSB Emergency Information Flipchart – should already be posted in all labs. For chemical-specific first-aid information, see the Safety Data Sheet.

Special Handling and Storage Requirements
✓ Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from any source of heat or ignition.
✓ Segregate the chemicals from incompatible materials

Decontamination/Waste Disposal Procedure
No waste streams containing methylene chloride shall be disposed of in sinks. Wash hands and arms with soap and water after finished. Contaminated pipet tips, eppendorf tubes, and gloves should be discarded as hazardous waste according to UCSB EH&S waste disposal procedures - see “Chemical Waste Disposal” in Sec. II of the UCSB Chemical Hygiene Plan.

Safety Data Sheet (SDS) Location
Found online at: http://ehs.ucsb.edu/labsafety/msds

Designated Area
In general, DCM should always be used in a fume hood, glove box, or completely-sealed containers.

Prior Approval/Review Required
Anyone working for the first time with DCM in this laboratory must consult with Rachel Behrens. Users must study the relevant safety information and be aware of the appropriate waste disposal method.

LAB-SPECIFIC INFORMATION
DCM is a solvent used for dissolving compounds. It is used as a solvent in the mass spectrometer at room temperature and in small quantities (2 mL or less).
Sec. I: Laboratory-specific Chemical Hygiene Plan

Standard Operating Procedures: Working with Cryogens

Type of SOP: ☑ Process ☐ Hazardous Chemical ☑ Hazard Class

1. HAZARD OVERVIEW

These materials – liquid nitrogen, liquid helium and dry ice - are extremely cold (-100°C to -270°C) and, upon contact, can instantly freeze other materials. Serious tissue damage may occur upon exposure.

Evaporating liquid nitrogen or sublimating dry ice (carbon dioxide) will displace the air within a non-ventilated space possibly leading to suffocation. Generally, labs have adequate ventilation to prevent this, but do not work in a confined space with these materials. Note that individuals have died when working in a non-ventilated lab “cold room” where large quantities of dry ice were stored. The OSHA ceiling Permissible Exposure Limit for carbon dioxide is 30,000 ppm.

Be aware of ice that can plug or disable pressure-relief devices. Ensure adequate pressure relief mechanisms are functional, i.e., never use tight-fitting stoppers or closures without pressure-relief devices.

2. PERSONAL PROTECTIVE EQUIPMENT (PPE)

Special insulated gloves for working with cryogens should be employed. General PPE information is under Sec. II of the UCSB Chemical Hygiene Plan regarding:

- the UC PPE Policy and policy summary (what a PPE is needed and when/where to use)
- obtaining your PPE via use of the Laboratory Hazard Assessment Tool
- glove selection criteria
- respirator use, etc.

3. ENGINEERING/VENTILATION CONTROLS

Always work in a well-ventilated area with cryogens to prevent oxygen displacement. Even with dry ice there has been a lab fatality when an individual worked in a “cold room” that did not have any ventilation provided. For this reason, liquid cryogens should also not be transported on an occupied public elevator.

For further information see these pages in Sec. II of the UCSB Chemical Hygiene Plan:
- Fume Hood Usage Guide
- Criteria for Implementing Engineering Controls

4. SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS

- Do not move an over-pressurized container. Evacuate and seal area, call EH&S (x3194) or dial 911.
- Avoid trapping cryogenic liquids between closed sections of an apparatus.
- Dewar flasks or other glassware devices should be taped on the outside or provided with shatterproof protection to minimize flying glass particles in case of implosion. Dewar flasks should be vented with a bored or notched stopper.
Sec. I: Laboratory-specific Chemical Hygiene Plan

- Cool cryogenic containers slowly to reduce thermal shock and flashing of the material.
- When utilizing cold baths (cryogen + organic solvent), use in a hood with a catch pan. Be aware of increased fire hazard. Be prepared for vigorous solvent boiling upon initial addition of solvent.
- Avoid condensing oxygen (blue in color) and/or its contact with organic material when using liquid nitrogen. Flush cold traps with nitrogen or keep under vacuum to avoid condensation of oxygen from air within the trap. Condensed oxygen when contacted with organic materials can cause a powerful explosion.
- To avoid condensing oxygen from the air with liquid nitrogen/helium, check glassware and valves for cracks and other defects before beginning experimental work. Verify that systems assumed to be under vacuum are so by checking vacuum gauges regularly. You should be on the lookout for the possibility of condensed air within the apparatus.
- Storage of liquid nitrogen: use only approved low temperature containers. Make sure liquid nitrogen containers are vented to prevent pressure buildup. You must use extreme care when working with liquid nitrogen. Liquid nitrogen should not be stored in sealed containers, as tremendous pressure could result and an explosion is likely.
- Liquid helium requires specialized handling techniques and equipment due to over-pressurization hazards and icing.

5. SPILL AND INCIDENT PROCEDURES
Flood the area (skin and eyes) immediately with large quantities of cool water. See a doctor immediately if the skin is blistered or if the liquid nitrogen came in contact with your eyes.
See directions under the “Chemical Incident” and “Medical Emergency” tabs of the UCSB Emergency Information Flipchart – should already be posted in all labs.

6. WASTE DISPOSAL
Not applicable to cryogens – let evaporate. However, low-temperature baths such as those made from dry ice and acetone, do need to have the solvent disposed of properly. See “Chemical Waste” pages in Sec. II of the UCSB Chemical Hygiene Plan.

7. PRIOR APPROVAL/REVIEW REQUIRED
Anyone working for the first time with LN2 n this laboratory must consult with Rachel Behrens. Users must study the relevant safety information and be aware of the appropriate waste disposal method.

8. DESIGNATED AREA
As they deem necessary, the PI/supervisor should insert here any information about whether a special use-area is designated for this material/process.

9. FURTHER INFORMATION
Safety Data Sheets (MSDS) found online at: http://ehs.ucsb.edu/labsafety/msds
Prudent Practices in the Laboratory (National Research Council): Liquidified Gases and Cryogenic Liquids

10. LAB-SPECIFIC INFORMATION
LN2 is a liquid used for cooling the DSC and DMA instruments. It is also used as a gas source for the mass spectrometer at room temperature.

Note: Hazards Around You in MRL 1043 and 1050

- Pyrophoric Materials (e.g. lithium metal, potassium metal, sodium metal)
- Carcinogens (e.g. chloroform, methanol, 1,3 butadiene, benzene, ethylene oxide)
- Flammable liquids and gases (e.g. hydrogen gas, methanol, DMF)
- Ethylene Oxide
- Compressed Gases
- Cryogens (e.g. liquid nitrogen)
- Ozone
- High Vacuum Systems (e.g. Schlenk lines)

Although you may not be working with these materials directly while in the Polymer Facilities, please be aware that these chemicals and materials are around you and may be used while you are working in the lab space. Found online at: [http://ehs.ucsb.edu/labafety/msds](http://ehs.ucsb.edu/labafety/msds)
Sec. I: Laboratory-specific Chemical Hygiene Plan

Appendix A: Osha Quick Card Reference

<table>
<thead>
<tr>
<th>Health Hazard</th>
<th>Flame</th>
<th>Exclamation Mark</th>
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<tbody>
<tr>
<td>Carcinogen</td>
<td>Flammable</td>
<td>Instant (skin and eye)</td>
</tr>
<tr>
<td>Mutagenicity</td>
<td></td>
<td>Skin Sensitizer</td>
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<tr>
<td>Reproductive Toxicity</td>
<td></td>
<td>Acute Toxicity (harmful)</td>
</tr>
<tr>
<td>Respiratory Sensitizer</td>
<td></td>
<td>Nociceptive Effects</td>
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<tr>
<td>Target Organ Toxicity</td>
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<td>Respiratory Tract Instant</td>
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<tr>
<td>Aspiration Toxicity</td>
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<td>Hazardous to Ozone Layer</td>
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<tr>
<th>Gas Cylinder</th>
<th>Corrosion</th>
<th>Exploding Bomb</th>
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<tr>
<td>Gases Under Pressure</td>
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<td>Explosives</td>
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<tr>
<td></td>
<td>Skin Corrosion/ Burns</td>
<td>Self-Reactives</td>
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<td></td>
<td>Eye Damage</td>
<td>Organic Peroxides</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Flame Over Circle</th>
<th>Environment (Non-Mandatory)</th>
<th>Skull and Crossbones</th>
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<tbody>
<tr>
<td>Oxidizers</td>
<td></td>
<td>Acute Toxicity (fatal or toxic)</td>
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</table>

As of June 1, 2015, the Hazard Communication Standard (HCS) will require pictograms on labels to alert users of the chemical hazards to which they may be exposed. Each pictogram consists of a symbol on a white background framed within a red border and represents a distinct hazard(s). The pictogram on the label is determined by the chemical hazard classification.

For more information:
www.osha.gov  (800) 321-OSHA (6742)
Appendix B: MRL Emergency Operations Plan

Materials Research Laboratory  UCSB Building 615
Emergency Operations Plan
AKA Emergency Action Plan & Fire Prevention Plan
This plan is adopted by the MRL on June 17, 1998
Craig Hawker, Director

SUMMARY
In the event of a fire alarm or other emergency evacuation, all persons are to leave the MRL Building and to assemble on the sidewalk at the southwest corner of Engineering II. See area map for location.
In the event of a major earthquake, all persons are to seek shelter in a door frame or other protected space. After the earthquake stops, and as soon as it is safe, all persons are to exit the building and to assemble on the sidewalk at the southwest corner of Engineering II. See area map.

MRL EMERGENCY PERSONNEL
Dr. Amanda Strom is the Hazard Communication Coordinator (HCC) for the MRL. She is also a member of the campus Emergency Response Team (ERT) and responsible for most utility and construction issues affecting the MRL Building. She can be reached at x7925 or by e-mail at amanda@mrl.ucsb.edu. His office is on the second floor in Room 2066F. Joni Schwartz is the Management Services Officer for the MRL as well as the Alternate HCC. She can be reached at x8519 or by e-mail at joni@mrl.ucsb.edu. Her office is located on the second floor in Room 2066E.

PREPARATIONS
The MRL shall maintain an Emergency Response Kit and it shall be stored in the 2nd floor kitchen (Rm 2042). This kit shall contain at least an AM-FM portable radio, a flashlight, extra batteries, and a first aid kit. First aid kits shall be kept in the 2nd floor kitchen (Rm 2042), 3rd floor kitchen (Rm 3026), TEMPO 1023, and vestibule between Polymer lab and TEMPO (Rm 1137). Chemical spill cleanup kits shall be kept in the vestibule between Polymer lab and TEMPO (Rm 1137), and 1278 (contact Amanda Strom for access). Laboratories, offices, and storage areas are to be kept in a safe fashion and in compliance with all environmental and safety regulations and good practice. All tall furniture is to be secured so that it will not fall over in an earthquake. All chemicals are to be stored in an appropriate and compatible manner. Chemical bottles are to be secured against falling during an earthquake. Researchers and other individuals are strongly encouraged to have copies of valuable and irreplaceable information stored away from campus, so that it is both safe and accessible if a building is temporarily or permanently closed. At least one member of the MRL technical staff should be a member of the campus Emergency Response Team (ERT). This person will receive training in hazardous materials, drill with the campus team, and may be called upon to assist the team in a campus emergency. An up to date home telephone list is to be maintained and distributed to key MRL personnel. All MRL personnel are expected to be familiar with their role as stated in this document.

INFORMATION SOURCES IN AN EMERGENCY
In many emergencies, the campus will send a message to every voice mailbox on campus with a report about the status of the campus and any expectations about whether employees are expected...
Sec. I: Laboratory-specific Chemical Hygiene Plan

to come to work. The procedure to check one's voice mailbox from off campus is to call 893-8800, enter the last 4 digits of one's campus phone number when prompted for the mailbox number, press the * key, and then enter the 4 digit password when prompted. The following radio stations should have information about emergency conditions: KCSB 91.9 FM, KTMS 1250 AM, KUHL 1440 AM Santa Maria, and KVEN 1450 AM Ventura. KEYT Channel 3 and KCOY Channel 12 may have information on TV. The campus has set up an out of area telephone line for emergency information that is expected to survive a regional disaster. Calls are 55c. The number is (900) 200-8272. Conditions of state highways are provided by Cal Trans at (800) 427-7623. If the Emergency Operations Center is operational, they may have a recorded message about campus status at 893-8690. See also Campus Emergency Information

EMERGENCY DURING WORKING HOURS
Emergency Affecting the Entire Campus
If there is an emergency that affects the entire campus, but the MRL seems relatively safe, such as an earthquake, brush fire, or flood, the first duty would be to determine the actual status of the MRL building. Is anyone injured? Were any chemicals released? Is there any obvious damage to the building? Are communications functional? If there is no compelling reason to leave, personnel should stay at work keeping out of other hazardous areas, staying out of gridlocked traffic, and staying out of the way of emergency workers. The HCC or Alternate should determine if the Emergency Operations Center (EOC) has been activated. If it has, the HCC should see to it that a Departmental Emergency Status Report is filled out and delivered to the EOC. It should be faxed to x8659, if possible. If fax is not possible, it should be carried to the EH&S Building, Bldg. 565, room 1045. This building is on the north side of campus between the Facilities Yard and the Rec-Cen on Mesa Road. The HCC should then check for any additional information and let the rest of the department know about the status of the campus and community. As a member of the ERT, the HCC may be called to work with the ERT during a campus emergency; if this happens, the Alternate HCC will assume all HCC duties at the MRL Building.

Evacuation of MRL Building
If it becomes necessary to evacuate the building or if any building alarm calls for evacuation, then every person should do so as quickly as possible. Even if the alarm is known to be a test or an exercise, all persons are required to exit the building. No one is assigned the duty of forcing anyone else to leave. If possible, people should bring their valuables and lock their doors behind them as they leave the building. All people leaving the building from the upper floors should use the stairs and not use the elevator. At this time, there are no disabled persons working in the MRL Building that would require assistance leaving the building. Should a disabled person begin working at the MRL, someone will be assigned to assist them in an emergency evacuation.

After leaving the building, all people should assemble at the Emergency Assembly Point (EAP) which is on the sidewalk at the southwest corner of Engineering II, see area map for location. Should it be unsafe to assemble there, then people should assemble at the courtyard in front of (north of) the Geology Building. If possible, the Emergency Response Kit should be brought to the EAP by Jennifer Ybarra or, if she cannot, by Melissa Ruiz. No one is to re-enter the building until authorized to do so by County Fire or by UCSB Emergency Personnel. After a big earthquake or other severe incident, the building may be closed for several days or longer. At the EAP, each person working in each area of the building should gather with the other people from that area to determine if there is anyone
Sec. I: Laboratory-specific Chemical Hygiene Plan

missing. Building areas would include the third floor, the second floor, the team room, the TEMPO lab, the Polymers lab, the Spectroscopy lab, and the X-Ray lab. A personnel status report should be passed on to the HCC or the MSO as soon as possible. If the Fire Department or other Emergency Responders are called to the MRL Building, the HCC or MSO will meet them at the MRL Building Fire Alarm Panel Box as soon as possible after an alarm and will then inform them about the status of the building and especially its personnel. The Fire Alarm Panel Box is located on the first floor, just outside the building on the south side, near the door to room 1278. In a campus wide incident, the HCC will see to it that a Departmental Emergency Status Report is filled out and delivered to the EOC as described above in Emergency Affecting the Entire Campus.

EMERGENCY AFTER HOURS
In the event of an emergency when people are not at work, people should come to work at the usual time, provided it is reasonably safe to do so and provided that roads are passable. Each individual needs to take personal responsibility for their decision about whether it is possible to come to work or not. News about campus status, road conditions, etc. may be found through sources listed above under "INFORMATION SOURCES IN AN EMERGENCY". HCC and laboratory Development Engineers should attempt to come to the MRL to determine the status of the building and its laboratories.

EMERGENCY MANAGEMENT
Additional details about how to deal with the problems that follow are provided in the UCSB Laboratory Safety Program-Chemical Hygiene Plan black 3-ring binder in the section under Emergency Management. This binder should be available in every MRL laboratory and is accessible on-line at: http://ehs.ucsb.edu

During an Earthquake
Do not rush outdoors. Most injuries occur from falling glass, plaster, bricks, debris, and electrical lines as people are leaving the building. Stay put during the initial shaking. Protect yourself. If possible sit or stand against a wall or doorway, or get under a fixed object (desk, table, etc.) Otherwise, cover your head and protect your body until the shaking stops. Stay away from all glass surfaces and windowed hallways (windows, mirrors, etc.) and cabinets and bookshelves. ABOVE ALL, REMAIN CALM. Think before you act and resist the urge to panic.

After an Earthquake
Remember aftershocks may occur at any moment with nearly the same force as the original quake -- so be prepared. After the initial shock, and only after the shaking stops, survey your area for damage and trapped persons. If severe building damage has occurred or if life-threatening conditions are observed, evacuate the building as described above and go to the EAP, on the sidewalk at the southwest corner of Engineering II. Do not use the elevators for evacuation. Once outside the building, move into the open areas. Do not stand under overhangs on the outside of a building. They are usually the most structurally unsound part of the building, and the first to collapse or fall. Move away from power lines, and stay away from all structures.

Discovery of a Fire
Upon initial discovery of a fire, alert personnel in the immediate vicinity. If possible, put the fire out by covering it or using a fire extinguisher. If there is time or it would be helpful, ask someone to get
the HCC for assistance. After the fire is out, let the HCC know what happened as soon as possible. Anytime a fire extinguisher is used it must be recharged; call x3305 to have it recharged. If the fire cannot be put out, evacuate the area, close the doors to the room where the fire is located, and activate a Fire Alarm Pull Station or call 9-911 to report the fire. Once outside, let the HCC and MSO know what happened as soon as possible. Any fire in the MRL Building may contain hazardous materials along with any smoke. Stay upwind from any smoke or fire and avoid breathing any fumes. Any fire must be reported to the campus Fire Marshall. Usually the HCC will make this report.

**Hazardous Chemical Release**
If possible, a small and not too harmful chemical spill should be cleaned up immediately by the person who caused the spill. Appropriate personal protective equipment must be used. If there is any doubt about what to do, contact the HCC and/or the Development Engineer for that lab. Spill cleanup kits are available in Room 1023, 1033 and most other MRL wet labs. After the spill is cleaned up, let both the HCC and the lab Development Engineer know what occurred. In the event of a larger or more hazardous chemical release, evacuate the area immediately. Close off the room where the spill occurred. Contact the HCC or the lab Development Engineer immediately. For outside assistance, call the EH&S 24 hour hotline at x3194. For a very large or very hazardous spill call x3194 and contact the HCC IMMEDIATELY. Every chemical spill must be reported to EH&S within one day of the spill. Usually the HCC will make this report.

**Utility Failure**
Natural Gas Leak: If a strong smell of natural gas is detected, cease all operations; evacuate the area, and call the Campus Emergency Number, 9-911. DO NOT do anything that might cause a spark, such as turning a light switch or any electrical equipment on or off. Notify the HCC. Ventilation Problem: If odors come from the ventilation system, notify Facilities Management Dispatch at x2661, EH&S at x3194, and the HCC. If the odor seems as if it may be harmful, evacuate the area until it is investigated. If the odor suggests that a fire is in progress, activate the nearest Fire Alarm Pull Station or call 9-911. Other non-hazardous utility failures should be reported to FM at x2661 or to Amanda Strom.

**Medical Emergency**
People with serious medical problems need professional help immediately. In the worst cases, call 9-911 for paramedics or an ambulance. If the sick or injured person can travel: students may be taken to Student Health Services during working hours, x3371; and anyone may be taken to the Emergency Room at Goleta Valley Cottage Hospital at 351 S. Patterson Avenue, just south of Hollister Avenue in Goleta. Employees injured on the job may be covered by Worker’s Compensation. Campus Business Services guidelines about how medical service is to be provided in such cases has been inconsistent. Information about current policy for non-emergency treatment can be obtained by calling Mari Tyrrell-Simpson in Business Services at x4169. Any employee injured while working at or for UCSB is responsible to report the injury to the HCC or MSO as soon as possible. The term "employee" includes graduate students and anyone getting any kind of paycheck. California law requires that the "Employee Claim for Worker's Compensation Benefits" be given to any injured employee within one working day from the time the injury was reported to the employer.

**FULL EH&S MODEL EMERGENCY OPERATION PLAN AVAILABLE**
Sec. I: Laboratory-specific Chemical Hygiene Plan

The UCSB EH&S has written a model department EOP that contains a wealth of information and is very comprehensive. In the interest of brevity and with the expectation that MRL personnel will actually read it, this MRL EOP has been made as short as possible. Copies of the Model EOP are available at the MRL Safety Bulletin Board, from the HCC and from the MSO. In addition, it can be found on-line at: http://ehs.ucsb.edu/

MRL Area Map

![MRL Area Map Image]
Emergency exit plans for floors 1 through 3

EMERGENCY EXIT PLAN
MRL FIRST FLOOR

IN EMERGENCY DIAL 9-911
EMERGENCY SIGNALS, VOICE ANNOUNCEMENT & FLASHING LIGHT - EVACUATE
IN CASE OF FIRE USE STAIRWAY FOR EXIT
DO NOT USE ELEVATOR

EMERGENCY EXIT PLAN
MRL SECOND FLOOR

IN EMERGENCY DIAL 9-911
EMERGENCY SIGNALS, VOICE ANNOUNCEMENT & FLASHING LIGHT - EVACUATE
IN CASE OF FIRE USE STAIRWAY FOR EXIT
DO NOT USE ELEVATOR
Section I: Laboratory-specific Chemical Hygiene Plan

Appendix C: EH&S Laboratory Safety Fact Sheets

The following EH&S laboratory safety fact sheets are hyperlinked but also attached for ease of reading (accessed on 6/25/18 via http://ehs.ucsb.edu/units/labsfty/labrsc/factsheets/lsfacssheets.htm):

- Water reactive and pyrophoric materials
- Chemical Storage
- Housekeeping Guide for Labs
- Power Failures Guide
- Receiving Hazardous Materials Shipments in Non-Lab Areas
- Seismic Hazard Reduction Policies
- Time Sensitive Materials
- Centrifuge Safety
- Refrigerators and Freezers in Labs
- Chemical Waste Disposal
LABORATORY SAFETY FACT SHEET #37 Safe Use of Pyrophoric/ Water Reactive Reagents

Introduction: Pyrophoric and water reactive materials can ignite spontaneously on contact with air, moisture in the air, oxygen, or water. Failure to follow proper handling procedures can result in fire or explosion, leading to serious injuries, death and/or significant damage to facilities. This fact sheet describes the hazards, proper handling, disposal and emergency procedures for working with pyrophoric and water reactives.

Any handling of a pyrophor/water reactive material is high risk and must be controlled with adequate system design, direct supervision and training. These tasks are two person tasks and workers should not work alone.

Examples of Pyrophoric/Water Reactive Materials
• Grignard Reagents: RMgX (R=alkyl, X=halogen)
• Metal alkyls and aryls: Alkyl lithium compounds; tert-butyl lithium
• Metal carbonyls: Lithium carbonyl, nickel tetracarbonyl
• Metal powders (finely divided): Cobalt, iron, zinc, zirconium
• Metal hydrides: Sodium hydride, lithium aluminum hydride
• Nonmetal hydrides: Diethylarsine, diethylphosphine
• Non-metal alkyls: R₃B, R₃P, R₃As; tetramethyl silane, tributyl phosphine
• White and red phosphorus
• Group I (Alkali) metals: Lithium, potassium, sodium, sodium-potassium alloy (NaK), rubidium, cesium, francium
• Gases: Silane, dichlorosilane, diborane, phosphine, arsine

Hazards: Because these reagents 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/moisture. Some are toxic and many come dissolved or immersed in a flammable solvent. Other common hazards include corrosivity, teratogenicity, water reactivity, or peroxide formation, and may damage to the liver, kidneys, and central nervous system.

Controlling the Hazards: BEFORE working with pyrophoric or water reactive reagents, read the relevant Material Safety Data Sheets (MSDS), technical bulletins, and guidance documents to understand how to mitigate the hazards. The MSDS must be reviewed before using an unfamiliar chemical and periodically as a reminder. Users of reactive materials must be trained in proper lab technique and be able to demonstrate proficiency. Do not work alone or during off hours, when there are few people around to help. ALWAYS wear the appropriate personal protective equipment.
**Sec. I: Laboratory-specific Chemical Hygiene Plan**

Remove all excess and nonessential chemicals and equipment from the fume hood or glove box where pyrophoric or water reactive chemicals will be used. This will minimize the risk if a fire should occur. Keep combustible materials, including paper towels and Kimwipes, away from reactive reagents.

Keep the amount of pyrophoric or water reactive material present in your lab to the smallest amount practical. Use and handle the smallest quantity practical. It is better to do multiple transfers of small volumes than attempt to handle larger quantities (greater than about 20 mL). Alternatively, an appropriately engineered system, capable of safely handling the larger quantity must be designed, tested and properly used.

**Personal Protective Equipment (PPE)**

**Eye Protection**

A full face shield that meet the ANSI Z.87.1 1989 standard must be worn whenever handling pyrophoric chemicals (should have “Z87” stamp on it). Prescription eye glasses, safety glasses, and splash goggles will NOT provide adequate protection. A face shield, worn over safety eyewear, is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction.

All manipulations of pyrophoric chemicals which pose these risks must be carried out in a fume hood with the sash in the lowest feasible position.

**Skin Protection**

In general, chemical protective gloves are unacceptable when working with pyrophors. If the reactive material were to ignite and spill onto the hand, nitrile or latex gloves would also ignite and contribute to serious injury.

Nomex and related aramid fiber products are excellent fire retardant, but can significantly reduce dexterity. A Nomex flight glove (used by pilots to protect from heat and flash) works well.

**A fire retardant lab coat must be worn.** Special fire-resistant lab coats made from Nomex or other fire resistant materials are more expensive, but recommended for labs using these reagents routinely. Lab coats need to be buttoned and fit properly to cover as much skin as possible. Clothing, shirt and pants, should be cotton or wool. **Synthetic clothing is strongly discouraged.** Appropriate shoes that cover the entire foot (closed toe, closed heel, no holes in the top) must be worn.

**Safety Equipment:** Researchers working with reactive materials must have the proper equipment and the emergency phone number (9-911) readily available for any emergencies, prior to starting research activities. Acceptable extinguishing media include soda ash (lime) or dry sand to respond to fires. DO NOT use water to attempt to extinguish a pyrophoric/reactive material fire as it can actually enhance the combustion of some of these materials, e.g. metal compounds. A small beaker of dry sand or soda ash (lime) in the work area is useful to extinguish any small fire that occurs at the syringe tip and to receive any last drops of reagent from the syringe. Review the MSDS for the proper fire extinguisher to use with the given material.

**Eyewash/ Safety Shower**

A combination eyewash/safety shower should be within 10 seconds travel time where reactive chemicals are used. Inside the laboratory is optimum.

If a combination eyewash/safety shower is not available within the lab, an eyewash must be available (within 10 seconds travel distance) for immediate emergency use within the lab. Bottle type eyewash stations are not acceptable. A combination eyewash/shower must be available in the hallway or similar, within 10 seconds travel distance and accessible through only one door.
Sec. I: Laboratory-specific Chemical Hygiene Plan

Fume Hood
Many reactive chemicals release noxious or flammable gases upon decomposition 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 lab.

Glove (dry) box
Inert atmosphere glove boxes are an excellent device for the safe handling of reactive materials. Glove boxes used for this purpose should be in good working order and the moisture and oxygen levels of the atmosphere should be confirmed prior to introduction of reactive compounds into the box. Continuous monitoring of oxygen and moisture is highly recommended. Also, take into account interactions between items in the glovebox (e.g., nitrogen is not an inert gas for lithium metal as the lithium is reduced violently to lithium nitride).

Gas Cabinets
Storage of pyrophoric gases is described in the CA 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.

Storage and Disposal
Storage
Use and store minimal amounts of reactive chemicals. Do not store reactive chemicals with flammable materials or in a flammable liquids storage cabinet. Containers carrying reactive materials must be clearly labeled with the correct chemical name, in English, and hazard warning.
Store reactive materials as recommended in the MSDS. An inert gas-filled desiccator or glove box are suitable storage locations for most materials.
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 the material is stored.
NEVER return excess 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:
Dry any new empty containers thoroughly
Insert the septum into the neck in a way that prevents atmosphere from entering the clean dry (or reagent filled) flask.
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.
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.
For long-term storage, the septum should be secured with a copper wire (figure 1A).
For extra protection a second same-sized septa (sans holes) can be placed over the first (figure 1B).
Use parafilm around the outer septa and remove the parafilm and outer septum before accessing the reagent through the primary septum.
**Sec. I: Laboratory-specific Chemical Hygiene Plan**

**Fig. 1A** Septum wired to vessel

![Fig. 1B](image.png) For long-term storage, use a second septum

**Disposal of Pyrophoric Reagents**
Any container with a residue of reactive materials should never be left open to the atmosphere.
Any unused or unwanted reactive materials must be destroyed by transferring the materials to an appropriate reaction flask for hydrolysis and/or neutralization with adequate cooling.
The empty container should be rinsed three times with an inert dry COMPATIBLE solvent; this rinse solvent must also be neutralized or hydrolyzed. The rinse solvent must be added to and removed from the container under an inert atmosphere.
After the container is triple-rinsed, it should be left open in back of a hood or ambient atmosphere at a safe location for at least a week.
The empty container, solvent rinses and water rinse should be disposed as hazardous waste and should not be mixed with incompatible waste streams.

**Disposal of Pyrophoric or Water Reactive Contaminated Materials**
All materials – disposable gloves, wipers, bench paper, etc. - that are contaminated with pyrophoric chemicals should be disposed as hazardous waste. Proper and complete hazardous waste labeling of containers is vital.
The contaminated waste should not be left overnight in the open laboratory but must be properly contained to prevent fires.

**Important Steps to Follow:** Reactive reagents can be handled and stored safely as long as all exposure to atmospheric oxygen and moisture or other incompatible chemicals is avoided. Finely divided solids must be transferred under an inert atmosphere in a glove box. Liquids may be safely transferred without the use of a glove box by employing techniques and equipment discussed in the Aldrich Technical Information Bulletin AL-134. Pyrophoric gases must be handled in compliance with the California Fire Code, Chapter 41. Another good reference is “Manipulation of Air-sensitive Compounds” by Shriver and Drezdzon.
The California Fire Code prohibits the storage or use of pyrophorics in buildings not fully protected by an automatic sprinkler system. If you are using a pyrophoric in an unsprinklered building contact EH&S at x-4899 immediately so that we may assist you with the options available to mitigate the situation.

**Handling Pyrophoric Liquids**
Users should read and understand the Aldrich Technical Information Bulletin No. AL-134. The PI should also have in place laboratory-specific handling, storage, and disposal standard operating procedures. The standard operating procedures should be included in the lab Chemical Hygiene Plan.
By using proper syringe techniques, these reagents can be handled safely in the laboratory. The Aldrich Sure/Seal™ Packaging System provides a convenient method for storing and dispensing air-sensitive reagents. Schlenk
I-40

Sec. I: Laboratory-specific Chemical Hygiene Plan

glassware is another suitable option. The reagent can be dispensed using a syringe or double-tipped needle (canula) (16, 18 or 20 gauge) inserted through the hole in the metal cap, as shown in fig. 2 below. It is recommended that the plastic cap be replaced after each use and in particular for long-term storage.

Fig. 2 Double-tipped needle transfer of liquid reagent
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, as described above.

Emergency Procedures

Spill
DO NOT use water to attempt to extinguish a reactive material fire as it can actually enhance the combustion of some reactive materials, e.g. metal compounds.
Do not use combustible materials (paper towels) to clean up a spill, as these may increase the risk of igniting the reactive compound. Soda ash (powdered lime) or dry sand should be used to completely smother and cover any small spill that occurs.
A container of soda ash (powdered lime) or dry sand should be kept within arm’s length when working with a reactive material.
If anyone is exposed, or on fire, wash with copious amounts of water, except if metal compounds are involved, which can react violently with water. In the case of a metal fire, smothering the fire is a better course of action.
The recommended fire extinguisher is a standard dry powder (ABC) type. Class D extinguishers are recommended for combustible solid metal fires (e.g. sodium, LAH), but not for organolithium reagents.
Call 9-1-1 for emergency assistance and for assistance with all fires, even if extinguished.
Pyrophoric gas releases and associated fires, should be extinguished by remotely stopping the gas flow. NEVER ATTEMPT TO PUT OUT A GAS FIRE IF THE GAS IS FLOWING.

Sources and Acknowledgements:
Created from a variety of sources including: Brandeis University, Standard Operating Procedure for Pyrophoric Chemicals; University of Nebraska, Lincoln, Pyrophoric Chemicals Standard Operating Procedure; University of Pittsburgh Safety Manual, Flammable and Pyrophoric Gas; Rochester University, SOP for Pyrophoric Chemicals. Images from Sigma-Aldrich Technical Bulletins AL-134 and AL-164.
Personal communication with (and grateful acknowledgement to) Dr. Russell Vernon, Environmental Health and Safety, UC, Riverside; Dr. Joseph Pickel, Center for Nanophase Materials Sciences, Oak Ridge National Laboratory; Dr. Neal Langerman, Principal, Advanced Chemical Safety, Inc.; Dr. Frank Osterloh, Professor of Chemistry, UC Davis.
INTRODUCTION: If incompatible chemicals are inadvertently mixed a fire, explosion, or toxic release can easily occur. In earthquake-prone areas like Santa Barbara, it is particularly vital that chemicals be stored safely. Take steps now to prevent damage to your facility, or harm to lab personnel.

Below are some basic guidelines for chemical storage. Note however, that chemicals can often fall into more than one hazard category and therefore the chemical label and/or Material Data Safety Sheet (MSDS-see below) should be reviewed for specific storage requirements. Separate chemicals by adequate distance, or preferably by using physical barriers (e.g. storage cabinets). Avoid using the fume hood for chemical storage - this practice may interfere with the proper air flow of the hood. For especially dangerous materials, use a secondary container (e.g. plastic tub) large enough to contain a spill of the largest container.

Chemicals should be disposed based on - but not limited to - the following criteria: material has exceeded it's shelf life; the cap is deteriorating or the container is leaking; the container has inadequate hazard information; material is waste (by law all chemical wastes must be disposed of within one year).

**BASIC HAZARD GROUPS**

<table>
<thead>
<tr>
<th>Flammables</th>
<th>Corrosives</th>
<th>Oxidizers</th>
<th>Carcinogens</th>
<th>Water Reactives</th>
<th>Toxics</th>
<th>Pyrophorics</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Flammable Liquid" /></td>
<td><img src="image" alt="Corrosive" /></td>
<td><img src="image" alt="Oxidizer" /></td>
<td><img src="image" alt="Carcinogen" /></td>
<td><img src="image" alt="Water Reactive" /></td>
<td><img src="image" alt="Toxic" /></td>
<td><img src="image" alt="Pyrophoric" /></td>
</tr>
</tbody>
</table>

With the wide variety of chemicals used in laboratories, the list below is prioritized for materials that are **COMMONLY** used in a research laboratory. This chart indicates the most obvious chemical incompatibilities, and provides a segregation plan. For more specific chemical incompatibility information, please consult the manufacturer's MSDS, available at [http://www.ehs.ucsb.edu/units/labsfty/labsc/chemistry/lschemmsds.htm](http://www.ehs.ucsb.edu/units/labsfty/labsc/chemistry/lschemmsds.htm) or contact EH&S at X8243.

**ACIDS**

- Acetic Acid
- Chromic Acid
- Hydrochloric Acid
- Hydrofluoric Acid
- Nitric Acid
- Phosphoric Acid
- Sulfuric Acid
  - Indicates strong oxidizing acids, store per oxidizers section

**Storage Precautions:**

- Store bottles on low shelf areas, or in acid cabinets.
- Segregate oxidizing acids from organic acids, AND flammable materials.
- Segregate acids from bases, AND from active metals such as sodium, potassium, etc.
- Segregate acids from chemicals which could generate toxic gases, such as sodium cyanide, iron sulfide, etc.

**BASES**

- Ammonium Hydroxide
- Potassium Hydroxide
- Sodium Hydroxide

**Storage Precautions:**

- Separate bases from acids.
- Store bottles on low shelf areas, or in acid cabinets.
### FLAMMABLES

- Acetone
- Ethyl Acetate
- Isopropyl Alcohol
- Toluene
- Xylene
- Ethyl Ether
- Methanol
- Gasoline
- Propanol
- Hexane
- Tetrahydrofuran

**Storage Precautions:**
- Store in approved flammable storage cabinet(s) (required if there is more than 10 gallons in the lab).
- Separate from oxidizing acids and oxidizers.
- Keep away from any source of ignition (flames, localized heat or sparks).
- Use only "flammable storage" (desparked) refrigerators or freezers.

### OXIDIZERS

- Calcium Hypochlorite
- Bromine
- Ferric Chloride
- Hydrogen Peroxide
- Iodine
- Nitric Acid
- Nitrates, Salts of Perchloric Acid
- Peroxides, Salts of Chromic Acid
- Potassium
- Ferricyanide
- Sodium Nitrite

**Storage Precautions:**
- Keep away from flammables, organic solvents, and other combustible materials (i.e. paper, wood, etc.).
- Keep away from reducing agents.
- Store in a cool, dry place.

### PYROPHORIC SUBSTANCES

- Some finely divided metals
- Some organoaluminum compounds (LiAlH₄, Al(CH₃)₃)
- Silane
- Phosphorus, Yellow
  - Phosphorus, yellow should be stored and cut under water

**Storage Precautions:**
- Rigorously exclude air and water from container.
- Store away from flammables.
- Store in a cool, dry place.

### WATER REACTIVE CHEMICALS

- Calcium Carbide
- Phosphorus Trichloride
- Lithium
- Thionyl Chloride
- Magnesium
- Potassium
- Sodium
- Lithium, Potassium, and Sodium should be stored under Kerosene or Mineral Oil

**Storage Precautions:**
- Rigorously avoid exposure to water and air.
- Store away from flammables
- Store in a cool, dry place.

## HIGHLY TOXICS, CARCINOGENS, REPRODUCTIVE TOXINS

These chemicals can be very hazardous by themselves, or in combination with other chemicals. If they are easily inhaled, (gases and volatile liquids) then they are particularly hazardous. Suspected human carcinogens should also be stored as highly toxic. Lists of these materials are provided on our website:

[http://www.ehs.ucsb.edu/units/labsfty/labrsc/chemistry/lschem.htm](http://www.ehs.ucsb.edu/units/labsfty/labrsc/chemistry/lschem.htm)
Sec. I:  Laboratory-specific Chemical Hygiene Plan

Gases - Store in a gas cabinet or other ventilated cabinet
Fluorine
Hydrogen chloride
Nitric Oxide
Chlorine

Liquids: Seal tightly and store in a ventilated cabinet apart from incompatibles. Use secondary containment (e.g. plastic tub) to contain any spills.

Formaldehyde
Carbon disulfide
Mercury
Nickel carbonyl
Cyanide solutions

Solids - Store away from incompatibles (usually acids) that would release toxic gas upon contact.

Cyanides, Salts of Sulphides, Salts of
LABORATORY SAFETY FACT SHEET #31
HOUSEKEEPING AND CLUTTER IN THE LABORATORY

Fire, property loss, and injury can result from excessive clutter and poor housekeeping. Good housekeeping can also facilitate good relations within the lab, improve lab technique and make the lab a place you’re proud to bring visitors into. The route to a safer, clutter-free lab is to make it a group effort. All lab members should make it part of their daily routine. Below are a few simple steps that can be included in your daily work practices.

WHAT TO LOOK FOR IN YOUR LAB:

1. Chemicals
   - **Keep chemicals stored in the appropriate cabinets or designated storage rooms when not in use (NOT IN FUME HOODS).** Only obtain an amount to keep your test or research going, like a one day/week supply. This will free up lab bench space and, if you do have a spill it will minimize the amount of chemical released.
   - **Put away all reagents, samples, and personal materials.**
   - **Keep the lids on chemical containers.** This sounds obvious but it will effectively reduce the possibility of a spill and reduce any fumes released into your lab and it’s the law.
   - **Label all containers.** Make sure there are no unidentified containers; reagents, samples, drying papers with sample, or crucibles/boats with samples. Label all material by chemical name (Not just initials)

2. Cleaning Your Lab
   - Properly dispose of old or unwanted chemicals or any unnecessary items.
   - Damp wipe all benchtops until clean and in particular areas near weighing stations. Place absorbent paper near weighing stations or any where else necessary.
   - Clean up inside fume hoods.
   - Look inside all cabinets for leftover waste and any storage hazards.
   - Dispose broken glass trash and “sharps” bins into dumpster outside the building.
   - Recycle paper and cardboard properly where it will be promptly removed.
   - Unused or spare equipment should be stored in a designated storage room/area.
   - Equipment or furniture should not block walkways, electrical panels, or emergency eyewash or showers.
   - Check emergency egress path is maintained (minimum exit pathway in rooms is 28 inches)
   - Don’t move your housekeeping problem into the hallway or some other undesirable/illegal location.

3. How cluttered are your lab benches and hoods?
   - **Keep lab benches and hoods uncluttered as much as possible.** This may seem impossible when conducting complicated tests or have numerous test samples, but continually remind yourself to keep things organized.
   - **Keep containers and equipment away from the edge of benches.** Are you reaching over bottles, cultures, etc. to get to something? Chances are you’re about to knock something on the floor.
   - What about the shelves above your desk or lab bench? **Keep shelving as orderly as possible.** Be realistic about how much equipment and supplies one needs to store long term.

4. Other
   - **Implement a group clean-up session weekly, monthly, etc.** Verify the lab(s) are clean, organized and anything else required to make the lab look professional.
   - **Check for trip and slip hazards (e.g. oil leaks from pumps, electrical cords or hoses across walking path)**
LABORATORY SAFETY FACT SHEET # 32 Be Prepared for Power Failures

Extended power outages can affect the campus, or individual buildings. For updates about a power failure, contact your building coordinator (e.g. MSO), or Department Safety Rep. Listen to KCSB FM – 91.9 radio for updates. Should the campus experience an extended electrical outage, the Emergency Operations Center at the Environmental Health and Safety building will activate to manage the campus response.

Emergency Lighting and Power
Building emergency lighting provides enough illumination for a safe exit. The lighting will either be battery-powered, or run off an emergency generator. Battery-run units should last a couple of hours, but may fail sooner. Some campus buildings have emergency generators, but what is powered varies by building. They typically only power emergency exit lighting, life safety systems and laboratory exhaust. Electrical outlets in labs that are on an emergency generator are typically red in color.

Data Backup
Back up your computer files regularly so as not to lose data when the power goes off suddenly. Use an Uninterruptible Power Supply (UPS) for critical machines such as servers.

Power Failure in Laboratories

Before Power Fails

- Be sure the after-hours contact information on your lab door placard is up-to-date. Ideally, these individuals should be knowledgeable about all of the laboratory’s major operations, particularly those that are hazardous/sensitive to power outages.

- Put essential equipment on emergency power circuits if available. Contact Facilities Management - they may be able to provide additional service capacity, along with a small number of portable units that may be available to keep critical operations going during power interruptions.

- Make a list of equipment that must be reset or restarted once power returns. Keep instructions for doing so in a nearby place. Hazardous processes that operate unattended should be programmed to shut down safely during a power failure and not restart automatically when power returns.

- Identify an emergency source of dry ice if you have items that must be kept cold. Refrigerators and freezers will maintain their temperature for several hours if they are not opened. **Do not use dry ice in walk-in refrigerators or other confined areas** because hazardous concentrations of carbon dioxide gas will accumulate.
Sec. I: Laboratory-specific Chemical Hygiene Plan

While the Power is Off

- Shut down experiments that involve hazardous materials or equipment which automatically restart when power is available.

- Make sure that experiments are stable and do not create uncontrolled hazards such as dangerous vapors in a non-functioning fume hood.

- Check fume hoods. Stop any operations that may be emitting hazardous vapors. Cap all chemical containers that are safe to cap, and then close the fume hood sashes. Leave the room and contact EH&S if you notice any odors or physical symptoms.

- Check equipment on emergency power. In some cases, it may take 20 to 30 seconds for the emergency power to activate after a power failure.

- Disconnect equipment that runs unattended, and turn off unnecessary lights and equipment. This will reduce the risk of power surges and other unforeseen problems that could result when the power comes on unexpectedly.

- Check items stored in cold rooms and refrigerators. You may need to transfer vulnerable items to equipment served by emergency power.

When the Power Returns

- Reset/restart/check equipment. In particular, check that the air flow of your fume hood. Often, hoods will not automatically restart.

- If a refrigerator or freezer fails to restart, keep the door closed until it has been repaired and returns to a safe working temperature.

- Contact EH&S for assistance with any spill cleanup or disposal issues.

Other Emergency Planning Tips

Take this opportunity to review your lab and building emergency procedures before a power failure strikes. In particular, your Department Emergency Operations Plan will provide building-specific emergency response and evacuation information. Contact your Department Safety Rep to review. However, at minimum, every worker must know:

- emergency exit routes from the building, and the locations of the following relative to their work area: building Emergency Assembly Point, nearest fire extinguishers, nearest fire alarm pull station, lab emergency shower/eyewash and first-aid kit. If unsure, talk to your supervisor, or Department Safety Rep, or EH&S.
LABORATORY SAFETY FACT SHEET # 39 Safety Guidelines for Receiving Hazardous Materials Shipments in Non-Lab Areas

Many lab departments at UCSB do not have a dedicated shipping/receiving area. Therefore, hazardous materials packages are often delivered to administrative offices. Staff in these areas generally do not have experience with hazardous materials, or what to do if a package leaks, smells, or is broken. Although hazardous materials are generally well-packaged and problematic containers are rare, below are some general safety guidelines. However, circumstances may vary and appropriate judgment should be applied.

If a hazardous materials package is leaking, broken, or smells strongly: In most cases, broken containers should not be accepted. The package can often be safely taken back by the delivery person, once the box is adequately sealed. Consulting with local lab personnel, or EH&S will help with the decision whether it is safe to have the package returned.

If anyone is experiencing symptoms (e.g., cough, eye irritation) call 911.

Knowing the name of the material will greatly aid in determining the appropriate level of response. So, if there is any associated paperwork secure it.

Some lab chemicals are flammable. So, if a significant quantity of flammable liquid is spilled, there is a small possibility of fire. In this circumstance, evacuate the immediate area and seek immediate assistance from nearby lab personnel, or EH&S, to do a cleanup. While awaiting assistance, keep an eye on the spill from a safe distance to ensure it doesn’t ignite. Pull a fire alarm and evacuate the building if there is a fire. Fire extinguishers are available in all buildings, but should only be used by trained individuals.

If it is deemed safe to do so, move the package into the nearest fume hood, or outside. If in doubt, leave the package where it is, evacuate the room and close the door.

In the unlikely event that an individual is exposed to chemicals in their eyes, or skin, note that there are emergency shower and eyewash units inside each lab, or nearby in the hallway. In lieu of these, use a sink to immediately flush the affected area. Call 911.

Footnotes:
See also the UCSB Emergency Information Flipchart under Chemical Incidents
Packages of radioactive materials are only delivered to EH&S for subsequent delivery directly to a laboratory.
For example, most solid chemicals pose very little health threat from a broken container.
Contact EH&S at x-3194. If you get an answering machine, call 448-4089.
Upon request, fire extinguisher training is offered by EH&S for a sufficiently large group. Call x-7751.
Laboratory Safety Fact Sheet #1 Nonstructural Seismic Hazard Reduction Policies

Earthquakes have occurred and will continue to occur in the Santa Barbara area. This is of particular concern in UCSB laboratories where the presence of hazardous materials, compressed gases, high voltage sources, etc., would pose serious hazards to individuals and buildings in a quake. In addition, the presence of expensive, difficult to replace lab equipment makes the need for evaluating the seismic anchoring needs of your lab critical.

Campus policies:
All furnishings and equipment over 48 inches in height must be fastened to a wall or floor in a manner to prevent falling in an earthquake.

Storage of large, heavy items must be kept below head level.

All compressed gas cylinders must be secured individually to a solid structural member with 3/16 inch welded chain or equivalent bracing. At least one chain must be used to secure each cylinder at a point two-thirds up the cylinder’s height. C-clamp bench attachments and fiber/web strap attachments will not be allowed. Any variations of these requirements must be approved by Environmental Health & Safety.

Chemical storage shelving must have shelf lips or other restraining devices (e.g. wire or bungee cord along edge) installed to prevent chemicals from falling.

To prevent accidental mixing of chemicals that could result in a fire, explosion or toxic release, incompatible chemicals must be segregated into separate, labeled areas or into separate rigid secondary containment such as plastic tubs. For more specific information on the classification and storage of particular chemicals consult the UCSB Chemical Hygiene Plan or contact EH&S at x-4899.

Recommended practices:
While not a safety issue, there are often expensive pieces of lab equipment, e.g. electronics, that you may wish to seismically anchor. UCSB Central Stores carries products that work well for securing these items.

Based on earthquake experiences at Cal State Northridge, UCLA and UCSC it is recommended that researchers maintain extra copies of irreplaceable files such as research data in a separate location.

Responsibility: The responsibility for compliance and funding of these policies rests with the department Chair or department head. Lab supervisors are responsible for identifying and implementing areas where the above policies apply in their labs. Environmental Health & Safety will act in an advisory capacity.

References:
University Policy on Seismic Safety, rev. 5/2/94
University Policy on Nonstructural Seismic Hazard Reduction, Policy 5445, rev. 6/1/95
As recently described to the campus lab community, on 7/3 a campus lab had an old lecture bottle of anhydrous hydrogen fluoride undergo a spontaneous violent rupture due to long-term hydrogen buildup. This was a near-miss relative to serious injuries, fire, etc. The problem was the result of leaving a “time-sensitive material” in storage for longer than is recommended. We have subsequently found and removed another old cylinder of the same material.

Since there are other time-sensitive chemicals, this would seem a good time to request all labs to REVIEW YOUR CHEMICAL STOCKS AND DISPOSE OF MATERIALS THAT ARE POTENTIALLY UNSTABLE. Note, there is a difference between a time-sensitive chemical and a shock-sensitive chemical (not addressed here).

Chemical waste removal can be initiated by completing the EH&S on-line form. Waste disposal is free for research labs. If there is concern about the stability of a particular container, do not move it.

Time-sensitive chemicals include:

GASES: Vendors recommend corrosive gases (acids/bases) be disposed of within 2 years. This is true whether they suffer from hydrogen buildup or not. Larger cylinders must be returned to the vendor. Examples:

Hydrogen fluoride, anhydrous (see above)
Hydrogen bromide, anhydrous (long-term hydrogen buildup)
Hydrogen cyanide, anhydrous (violent polymerization can occur)
Hydrogen sulfide, anhydrous (anecdotal reports of pressure buildup)
Hydrogen chloride, anhydrous (not reported as unstable, but any corrosive gas can eventually attack the cylinder fittings)

SOLIDS/LIQUIDS: For a good overview of these hazards click on: doi:10.1016/j.chs.2004.05.014 Note that peroxidizable solvents (e.g. ethers) are the most common material in this category.

For a review of good management practices with these materials see the related article: doi:10.1016/j.chs.2004.05.017

Note that the most fundamental management tasks are to:

a. know what you have in stock,
b. date materials that are time-sensitive,
c. purge them as needed

Questions on these issues can be addressed to David.Vandenberg@ehs.ucsb.edu However, for particular chemicals, please first consult the MSDS and container label for the material.
1. Before using any centrifuge review the owner’s manual- obtain a copy of the manual if it is not available. Check rotor for rough spots, pitting & discoloration. Consult manufacturer if discovered.

2. High speed rotor heads are prone to metal fatigue. Each rotor should be accompanied by its own log book indicating the number of hours run at top or de-rated speeds. Do not exceed the design mass for the maximum speed of the rotor. Failure to observe this precaution can result in dangerous and expensive rotor disintegration.

3. Make sure rotor, tubes and spindle are dry and clean and that the rotor is properly seated and secured to the drive hub. Tubes must be properly balanced in rotor (½ gram at 1 G is roughly equivalent to 250 Kg @ 500,000 G’s).

4. Before use, tubes should be checked for cracks. The inside of cups should be inspected for rough walls caused by erosion and adhering matter should be removed. Metal or plastic tubes (other than nitrocellulose) should be used whenever possible.

5. Use sealed rotors, sealed buckets, or a guard bowl with gasketed cover as well as safety centrifuge tubes (tube or bottle carrier with sealable cap or “O” gasketed cap).

6. After use, tubes, rotors, and centrifuge interiors should be cleaned and disinfected.

7. If a tube breaks, the centrifuge should be turned off, allowed to stand undisturbed for 15 minutes before opening. Clean and disinfect the rotor. If infectious material was placed in the centrifuge, plan proper decontamination and cleanup.

8. Cleaning and disinfection of tubes, rotors and other components requires considerable care. No single method is suitable for all items, and the various manufacturers’ recommendations must be followed to avoid rotor fatigue, distortion and corrosion.

9. Once run is complete, make sure the rotor has STOPPED before opening the centrifuge lid.

**Infectious Materials**

1. High- speed centrifuge chambers are connected to a vacuum pump. If there is a breakage or accidental dispersion of infected particles, the pump and pump oil will become contaminated. A HEPA filter should be placed between the centrifuge inner chamber and the vacuum pump when containment is needed.

2. Centrifuge tubes or bottles should only be filled, loaded into rotors, and removed from rotors from within a biological safety cabinet. This practice provides containment in case a tube or bottle leaks or breaks.

*For further information, contact the EH&S Laboratory Safety Specialist at x-4899*
Certain refrigerator/freezer units are designed for the safe storage of flammable materials, and to prevent potentially injurious explosions in your lab. These units have special protections to prevent ignition of flammable vapors. For example, the light switch, defrost feature, and thermostat inside the storage compartment have been removed or relocated outside the box. This is critical, since flammable vapors coupled with an ignition source could result in a explosion. Before purchasing a new refrigerator/freezer, or using an existing one, consider whether chemicals will be used for storage in this unit.

There are two types of refrigerator/freezer models that should be considered, depending on the type of hazardous material the unit will store.

I. FLAMMABLE MATERIAL STORAGE REFRIGERATORS/FREEZERS:
These have no internal electrical components which could trigger an explosion inside the unit. These must always be used for storage of volatile materials.

II. EXPLOSION-PROOF REFRIGERATORS/FREEZERS:
These units prevent triggering of interior or exterior explosions in a hazardous environment. Every motor and thermostat is designed to prevent arcing and possible ignition. They are used for storage of volatile materials in areas with explosive atmospheres. This model is rarely necessary in lab environments.

All refrigerator/freezer purchases and modifications on campus must be pre-approved by EH&S at X8243. In addition, all approved refrigerator/freezer units storing flammable materials must be labeled with signage reading, “Approved For Chemical Storage, No Food Storage”. All refrigerator/freezer units in labs, which are not approved for storage of flammable materials must be affixed with signage reading, “Explosion Hazard”. Contact EH&S to receive your free label(s).

For further information contact EH&S Laboratory Safety Specialist at X4899
LABORATORY SAFETY FACT SHEET #6 CHEMICAL WASTE DISPOSAL

REGULATIONS

- Hazardous waste regulations are stringent and penalties for violations can be severe. Santa Barbara County inspects UCSB labs for compliance on a regular basis.

STORAGE

- Store chemical waste in a designated area.
- Label area as, "HAZARDOUS WASTE STORAGE AREA"
- Store chemicals in containers compatible with, and durable enough for, the waste. Liquid waste must be in screw top containers. Do not overfill container, allow for expansion.
- Gas cylinders and lecture bottles must have regulators removed.

LABELING

- Identify waste by proper chemical name (no abbreviations or chemical structures).
- List chemical names of hazardous components in that mixture by percent weight.
- Deface existing labels when reusing containers.

- Label and date container(s) when the first drop of waste is added. Hazardous waste shall be disposed within 9 months of start date.
- Use UCSB HAZARDOUS WASTE label on all hazardous waste containers. All portions of the label must be completed.
- Labels are available for free in all science storerooms.

SEGREGATION: group waste into the following categories:

- halogenated organics (dichloromethane, chloroform)
- non-halogenated organics (acetone, methanol, ethanol, xylene)
- acids with pH 2 or less (HCl, sulfuric acid)
- alkaline solutions of pH 12.5 or greater (sodium hydroxide)
- alkali metals and other water reactives (sodium, acetyl chloride)
- heavy metal solutions and salts (mercury, silver, zinc)
- strong oxidizers (nitric acid, chlorates, permanganates)
- peroxide-forming chemicals (dioxane, THF)
- cyanides (potassium cyanide, hydrogen cyanide)
- chemical carcinogens (acrylonitrile, inorganic arsenic)
- unstable chemicals
- other toxic chemicals

DISPOSAL

- Chemicals may not be disposed in regular trash, sink disposal, or allowed to evaporate.
- Complete a UCSB Waste Pick-up Request Form. Send either by campus mail or fax (X7259). Also available on EH&S website http://ehs.ucsb.edu for electronic submission.

  - EH&S cannot accept responsibility for improperly labeled, packaged, and/or segregated chemicals, and will not pick them up.

Further information contact EH&S, Hazardous Waste Program X3293

- Transferring waste into appropriate containers is the generators responsibility.
  - Waste containers become the property of EH&S and will not be returned.
  - Before working with hazardous material attend EH&S Lab Safety course, call X4899 for next available training date.

CHEMICAL SPILL

- Clean up a spill if you have the proper equipment and feel comfortable doing so. Otherwise, contact EH&S 24-hour line X3194.
Appendix D: Laboratory Self-Inspection Checklist


Laboratory Self-Inspection Checklist

EH&S inspects all labs on campus at least annually. However, lab supervisors should initiate regular self-inspections (recommend minimum of twice-a-year) for the following reasons:

- Under California law (OSHA), supervisors (PIs) are required to: “… include procedures for identifying and evaluating work place hazards including scheduled periodic inspections to identify unsafe conditions and work practices.”
- Beyond any regulatory requirements, doing regular self-inspections will clearly increase the level of safety in your area.

To aid you in your surveys, a Self-Inspection Checklist follows, this is not a list of every possible safety issue, but are guidelines. Most items are based on applicable regulations or campus policy. Radiation and biohazard issues are not addressed here because they are highly specialized and these labs receive targeted EH&S visits. More information is also available at http://ehs.ucsb.edu. The links (underlined) noted below lead to further information.

Hazardous Waste

1. Are personnel generating chemical waste trained with waste disposal procedures? Individuals who have not taken the UCSB Fundamentals of Lab Safety course (live or on the EH&S website) must take this course before generating hazardous waste for disposal. 
   Online Hazardous Waste Generator training *(EH23)
   *(This course meets the waste management training requirements enforced by Cal-EPA)*

2. Is the illegal disposal of hazardous substances down the drain prevented?

3. Are all hazardous waste containers labeled with the official UCSB Hazardous Waste label?
   - Is there a supply of UCSB waste labels handy (available in all campus storerooms)?
   - Are labels attached when the first drop of waste goes into the container?
   - Are all constituents in mixtures identified, as well as their concentrations?
     Do not use generic names like “Waste or Organic waste” instead use proper chemical name(s).
   - Are chemically incompatible wastes segregated?
   - Is there a designated area for storage of hazardous waste and labeled as such?

4. Are lab personnel instructed not to dispose of chemicals by fume hood evaporation?
   By law, waste containers must be capped when not in use.

5. Is chemical waste disposed of within 9 months of their accumulation, regardless how much material remains inside the container? Contact EH&S for waste disposal.

6. Are all “sharps” (syringes, razor blades, etc.) disposed in puncture resistant, leak-resistant containers and sealed tightly to preclude loss of contents? Submit an online request for EH&S disposal following the guidelines.

Laboratory Glass: Is there a designated glass disposal container in the lab?
Lab personnel are responsible to empty these into their bldg. red-lidded trash can – custodial staff will not do so.

7. Obtain Free Waste Venting Caps: If you use Aqua Regia solutions, Piranha Solutions, Nitric acid waste, contact us (link sends e-mail) to receive free venting caps. For more info, view Venting cap video (link is external).
Sec. I: Laboratory-specific Chemical Hygiene Plan

Chemical Safety

1. Chemical Hygiene Plan (CHP)

- Is your lab's legally-required (Cal-OSHA) CHP Lab-specific complete and shared with all workers?
- Has the CHP been reviewed and evaluated for effectiveness, must be done annually?
- Have lab personnel signed the training page?
- Does your CHP address your use of OSHA Particularly Hazardous Substances (human carcinogens, acute toxins, reproductive toxins, and pyrophorics)? Personnel working with these materials shall receive documented training.

2. Are Cal-OSHA regulated carcinogens such as formaldehyde/formalin, dichloromethane, and benzene always used in a fume hood and with appropriate gloves/eyewear?

3. Are chemical containers properly labeled with chemical name and hazard type of the material (e.g., repackaged materials and lab-synthesized materials)? No symbols or abbreviations may be used.

4. Are stored chemicals segregated according to hazard classification/compatibility (acids, bases, flammables, oxidizers, water reactivities, etc.)? Compatibility Chemical Storage Chart

5. Are all containers of peroxide-forming chemicals (e.g., ethers) dated upon receipt and disposed of within the prescribed time period (contact EH&S for prompt disposal)? Peroxides can be explosively unstable.

6. Check chemical stocks regularly for materials that can become dangerously unstable over time and dispose of via EH&S. Links to descriptions of these materials can be found at: http://www.ehs.ucsb.edu/files/docs/fs/factsheets/Time_sensitive_materials.pdf

7. Are flammable liquids kept inside approved flammable storage cabinets whenever possible?

- Are flammable liquids always stored in approved flammable cabinets when in excess of 10 gallons?
- Do you have large volumes of flammable solvents (e.g., multiple cases or drums) in storage that are above what is reasonably needed? The quantities of flammables that can legally be stored are regulated by CA Fire Code. Please don't stockpile large quantities of these materials.
- Are flammable liquids stored away from sources of heat, ignition, electrical equipment or sources of static electricity?
- Static Electricity – Electrically-ground all metal containers/equipment involved in the pumping/pouring of flammable liquids to prevent buildup of static electricity as an ignition source. Flammable liquids dispensed from metal cans must be bonded and grounded to prevent a fire as explained in this laboratory SOP, “Advanced Flammable and Combustible Liquids Handling”.

8. Are acid volumes greater than 10 gallons stored in an approved storage cabinet?

9. Is there a catch pan beneath manometers, barometers, etc. which contain large quantities of mercury?

10. It is highly recommended chemical spill cleanup materials be available. Are all lab workers familiar with the location of spill cleanup kits?

   Note: Some lab buildings have a designated "spill closet" – generally keyed to graduate master key.
Sec. I:  Laboratory-specific Chemical Hygiene Plan

Laboratory Equipment

1. Are the eyewash and emergency shower stations free of any obstructions which would prevent ready access? These units are tested and documented by FM regularly. It is recommended that labs run their eyewash units monthly to maintain clean water in the lines.

2. Have fume hoods been EH&S tested within the year (check label)?
   - Is an air flow/digital indicator present and operational? If not, contact EHS for repair.
   - Is lab equipment or chemicals within the hood minimized? Keep only items in use.
   - Are air entry slots at back of hood kept clear of obstructions? Cluttered hoods interfere with proper air flow.
   - Is the front sash lowered to the appropriate level "red arrow mark" when hood is in use? If the low flow alarm engages, lower the sash until the alarm stops. If the alarm continues when the sash is lowered to the "red arrow mark," please contact EHS at x3743. DO NOT over-ride the safety alarm by permanently engaging the "Mute" or "Emergency" button (e.g., with tape, paper clips, etc.).
   - Has everyone using a fume hood been properly trained to use their fume hood? General fume hood use is covered in the Fundamentals of Lab Safety training course. The training however, does not cover lab specific hood use. Ensure lab members have documented their training.

3. Are biological safety cabinets certified annually or when moved (check sticker) and are they the proper types for the work being conducted?

4. Do labs using non-ionizing radiation equipment, such as lasers, microwaves, and ultraviolet light sources, have properly posted warning signs and shielded work areas? Documented training?

5. Compressed gas cylinders
   - Are cylinders dated upon arrival and contents clearly identified?
   - Inspect regularly for defects, i.e., excessive rust, dents, bulging, corrosion, etc.
   - Unidentified cylinders should be marked, "CONTENTS UNKNOWN" and returned to the manufacturer.
   - Non-lecture bottles ≥ 5 years old must be returned to the manufacturer to ensure they are safety/pressure tested as required by law ("hydrostatic testing"). Check stamped date on cylinder when it was last tested.
   - Corrosive gases (e.g., HF, HBr, HCl, H₂S) can degrade the cylinder over time and/or produce dangerously high pressures of hydrogen. Dispose of within 2 years.
   - Are cylinders secured upright with welded chains and brackets bolted to a wall, bench or other secure object (no C-clamps type)?
   - Are protective caps in place while cylinders are not in use?
   - Flammable gases (e.g., hydrogen, methane) tubing should be equipped with a flash arrester to prevent flame flashback to cylinder. Available from gas vendors.
   - Ensure gas tubing is appropriate for the material being used.
   - Do not use Teflon tape or "pipe dope" on CGA connections unless specified by the equipment manufacturer. Particularly avoid this with oxygen systems.
   - Use of large cylinders of highly toxic gases must be reviewed/approved (contact EHS, x-4899)
   - Highly toxic gas cylinders should be equipped with a reduced flow orifice (RFO) connection to prevent rapid discharge of cylinder contents. Available from gas vendors.
   - Gas cabinets with toxic or flammable gas delivery manifolds often have an excessive flow detection and auto-shutoff valve built-in. Verify that this safety feature is functional.

6. Lab refrigerators
   - Are refrigerators for storing flammables clearly posted with signage indicating they are safe for such storage? (e.g., "desparked," "lab-safe," "explosion-proof," "flammable storage").
   - Are refrigerators that are NOT designed for flammables storage clearly marked as such? (this is very important to prevent a potential explosion)
   - Are all chemical storage refrigerators marked with "No Food" labels?
   - Refrigerators in labs utilized for food or drinks should be marked "Food Only/No Chemicals?"
7. Is the location of manuals/instructions for each piece of equipment known?

8. Are the belt guards in place on all pumps, etc.?

9. **Solvent stills with water-reactive drying agents**
   - Are solvent stills clearly labeled with the solvent name and drying reagent?

   Ensure water-flow monitor are installed that would automatically shut off the heating mantles in the event of cooling water loss (pic with arrow). Periodically test monitors by shutting down the water flow to verify the system is functioning properly. They are available commercially.
   - We strongly recommend this important safety device be adopted. Fires associated with stills are not uncommon, including the $3M fire at UCI in 2001.

   Ensure secondary containment pans are beneath the stills. In the event of a system leak this should capture any leakage and prevent the solvent from spreading and finding an ignition source.

   **Quenching Solvent Stills** - The quenching of used still-pots is potentially dangerous but can be done safely if appropriate precautions are taken. “See EH&S Fact Sheet on still quenching”

   **Pressurized Systems** - Inspect and test all high pressure vessels regularly per the owner’s manual requirements. Each vessel should have a use-log of: experiment conditions, dates of runs, testing/maintenance history, etc. in order to track the vessel’s life-expectancy. Pressure vessels must include a functional over-pressurization rupture disk to prevent a catastrophic vessel failure.

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**General Safety Concerns**

1. Has EH&S posted outside the lab an emergency information contact sign, indicating the hazards within, responsible persons and phone numbers? Is the information correct? Call EH&S to update (x-8243).

2. Has the UCSB Campus Emergency Flip Chart been posted in the work area? Has the, Building-Specific Emergency Information section page been completed?
Sec. I: Laboratory-specific Chemical Hygiene Plan

3. Are rooms containing regulated hazardous substances, such as infectious and radioactive materials, posted with warning/caution signs and appropriate authorizations?

4. Are aisles free of obstructions? Minimum clearance for lab aisles is 2 ft.

5. Do work areas have adequate ventilation and illumination? To prevent suffocation, verify that fresh air is supplied to cold/hot rooms that are used as work areas. Check emergency door release and alarm mechanisms.

6. Are fire extinguishers functional (plastic seal and metal pin intact and dry powder units show pressure)? Are the extinguishers located on their wall hooks? Is the area in front of the extinguishers accessible?

7. Are food and beverages kept out of chemical work areas and out of laboratory refrigerators?

8. Is everyone familiar with the UCSB Laboratory Personal Protective Equipment (PPE) Policy? Minimum attire: 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; unless exceptions have been determined per policy.

   For more PPE information, including glove reference charts, click link.

   a. Any extra or unwanted lab coats in the laboratory? To recycle unwanted coats, drop them into a designated bin located in the same locations as the existing coat laundering stations. It is important to only issue new workers coats via the LHAT and campus PPE storeroom, so that the coat issuance can be legally documented and the individual gets the proper type and size of coat.

9. Have all respirator and dust mask users been certified through the EH&S UCSB Respiratory Protection Program?

10. Is the level of housekeeping in the lab satisfactory?

<table>
<thead>
<tr>
<th>WHAT TO LOOK FOR IN YOUR LAB:</th>
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<tbody>
<tr>
<td>No hazardous materials stored on floor and away from the edge of benches</td>
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<tr>
<td>Aisles, secondary exits and corridors kept clear</td>
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<tr>
<td>Keep lab benches and hoods as uncluttered as possible.</td>
</tr>
<tr>
<td>Glassware that is scattered on benches and out in the open clutters working areas, is easily broken, will not stay clean, and, if dirty, may be confused for clean glassware and could potentially negate any viable research.</td>
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11. Lab doors are fire-rated and therefore cannot be propped open with a wedge or other device. Discontinue use of these, or SB County Fire may confiscate them and cite the University.

12. Secure your highly hazardous materials. e.g. highly toxic gas, radiation, select biological agents. Ensure the lab door(s), freezers, refrigerators, storage cabinets, etc. with these materials are locked whenever the lab is unattended.
Sec. I:  Laboratory-specific Chemical Hygiene Plan

**Electrical Safety**

1. Check electrical equipment and inspect for frayed cords and damaged connections? Electrical tape is prohibited.

2. Multiple outlet strips plugged directly into a wall outlet? Does the power strip have a circuit breaker? Extension cords are not to be permanently used with power strips.

3. Are employees instructed not to use extension cords in place of permanent wiring (use allowed if only on a temporary, immediate, basis)? Have permanent receptacles installed for long-term electricity needs.
   - Ensure extension cords are 14-gauge (heavy duty) at a minimum, and **temporarily** servicing only one appliance or fixture?
   - Ensure extension cord is plugged directly into receptacle. Extension cords should never be used plugged end-to-end; use the proper length cord.
   - If extension cords are used, ensure cords are not running through walls, ceiling or doors?

4. Are cord guards provided across an aisle or other passageway to prevent tripping?

5. Is the electrical equipment grounded (three-prong plugs) or double insulated?
   - Are 3-prong plugs only used for 3-prong receptacles, and never altered to fit into an outlet?

6. Are Ground Fault Circuit Interrupters in place where electrical outlets are in use within 6 feet of water? Ensure GFCI's are working properly by using the "TEST" button.

7. Are all electrical boxes, panels and receptacles covered to protect against electrocution?

8. Are control switches, circuit breakers and electrical panels free of obstructions? These items must be accessible at all times.

9. Are high voltage control panels and access doors posted?
Sec. I: Laboratory-specific Chemical Hygiene Plan

Seismic Safety

1. Do shelves used for chemical storage have seismic restraining devices (e.g., lip, wire or bungee cord) installed to prevent chemicals from falling? Is all valuable or hazardous equipment seismically anchored?

Visit web links for securing lab instruments & appliances:

Earthquake Restraint System for Optical Tables

Securing Your Stuff

2. Are cabinets, chemical shelves and furniture over 42 inches in height braced against walls to prevent their falling over in the event of an earthquake?

3. Is overhead storage of heavy objects minimized and restrained?

Administrative

(Note: these training requirements must be met by supervisors to satisfy their personal regulatory obligations and reduce their liability)

1. Per UCSB policy the Fundamentals of Laboratory Safety orientation is required for all new UCSB lab workers before lab access is granted. Verify everyone has attended either the live or online course.

2. Ensure everyone has gone through the Laboratory Hazard Assessment Tool (LHAT)? The LHAT provides a summary report of hazards present in the laboratory and the PPE recommended for laboratory workers. The LHAT must be updated as hazards change, and at least once every 12 months, irrespective of changes to hazards or personnel.

3. Has each lab member completed the Training Needs Assessment form? Supervisors are responsible for conducting and documenting the laboratory training needs assessment per policy.

4. Ensure all lab personnel are familiar with the following and document in the Training Needs Assessment:

- How to access Safety Data Sheets (formerly MSDS)?
- Know the location of the emergency eyewash/shower station?
- The Emergency Assembly Point for your building?
- The location of the nearest fire alarm pull station?
- The three basic types of fire extinguishers and their applicability?
- The location/availability of first aid kits within the building?
- The location of the circuit breaker box?
- The availability/purpose of the UCSB Hazard Reporting Form?
- The identity of your Department Safety Rep?
- The location/purpose of your building’s Safety Corner bulletin board?
- The location of the Automated External Defibrillator (AED), available in some departments?

Any questions, please call X-8243.
Appendix E: MRL Injury Illness Prevention Plan


Materials Research Laboratory Combined
Injury & Illness Prevention Plan and
Hazard Communication Plan

This document is formally adopted by the Materials Research Laboratory.
Dr. Ram Seshadri
Director

It is the policy of the Materials Research Laboratory (MRL) that all persons working under our auspices are entitled to as safe a work environment as possible. It is also our policy that all health, safety, and environmental protection regulations and good practice are to be followed by all persons working within the MRL.

This combined Injury & Illness Prevention Plan (IIPP) and Hazard Communication Plan (HCP) spell out our specific commitments to this goal.

The following policies apply to all persons working in the MRL Building and otherwise working under the auspices of the MRL, including Faculty, Staff, Post Doctoral Researchers, Graduate Students, Undergraduate Researchers, Summer Interns, and paid student helpers. All of these people will be referred to as employees.

The following people hold the offices specified in this document.
- Director: Dr. Ram Seshadri
- Hazard Communication Coordinator (HCC): Amanda Strom
- Management Services Officer (MSO) & Alternate Hazard Communication Coordinator: Joni Schwartz
- Chemistry Laboratory Development Engineer: Amanda Strom
- Spectroscopy Laboratory Development Engineer: Jerry Hu
- X-Ray Laboratory Development Engineer: Youli Li

Injury & Illness Prevention Plan
Title 8 of the California Code of Regulations specifies eight specific topics that must be addressed by every employer in California as part of the required IIPP. In the following the MRL adopts specific policies to meet the demands of Title 8 and to protect the people working under the MRL.

Authority & Responsibility
The Director of the MRL has the authority and responsibility to carry out the terms of this plan. The Director delegates authority for implementation of this plan to the departmental Hazard Communication Coordinator (HCC) and the departmental Management Service Officer (MSO).

Compliance with Safe Work Practices
The Director, the HCC, and the MSO are responsible to see to it that all safe work practices are followed at the MRL.

The Principal Investigators and laboratory Development Engineers are responsible to see to it that work within their laboratories follow safe work practice.

Each person working at the MRL is responsible to understand the nature and hazards of their work and to take all necessary and prudent precautions.

Communicating Safety Issues
The MRL will make sure that employees become knowledgeable about health and safety issues, practices, and protections through the following practices:

1. A Safety Bulletin Board will be maintained in Room 2042 on the second floor of the MRL Building.
Sec. I: Laboratory-specific Chemical Hygiene Plan

2. All persons working within MRL laboratories are required to attend the EH&S Laboratory Safety Class at least once while at UCSB.

3. Employees are required to read the Material Safety Data Sheets (MSDS) and/or other references for all potential hazardous materials that they may come in contact with. The HCC will maintain reference materials including Sax's Dangerous Properties of Industrial Materials, the Merck Index, and hard copies of some MSDS. Computers for the downloading of MSDS are available to everyone. MSDS may be found on the Internet at http://ehs.ucsb.edu/units/labsfty/labrsc/chemistry/lschemmsds.htm

4. Research group meetings should address safety issues whenever helpful.

5. New employees shall be introduced to the MRL laboratories by more senior employees.

6. New or continuing employees are not to begin new procedures until they have been checked out on the apparatus or process by a more experienced team member and/or they have comprehensively studied the required operation and its hazards.

Identifying Work Place Hazards
Whenever a unsafe situation is discovered it should be reported to the Laboratory Development Engineer, the Principal Investigator, and/or the HCC.

Campus EH&S is to periodically inspect each MRL Laboratory and work place for hazards. The results of these inspections will be transmitted in written form to the MRL MSO, HCC, and Principal Investigators by EH&S.

Laboratory Development Engineers are to review laboratory safety practice and hardware periodically.

Hazard Report Forms are to be available on the Safety Bulletin Board in Room 2042 of the MRL Building. These forms may be used anonymously.

Procedures for Investigating Injuries and Illness
Any injury to an employee requires the following response:
1. Any employee injured on the job must report the injury to their supervisor, the MSO, or the HCC as soon as possible after the injury.
2. The HCC is to investigate the nature and cause of the injury.
3. EH&S may also investigate the nature and cause of the injury.
4. The "Employee Claim for Worker's Compensation Benefits Form" must be given or mailed to the injured employee within one working day from the time when the injury is reported to the employer. The employee has the option of filling out and returning this form to the MSO.
5. The injured employee's supervisor, usually the Principal Investigator or the MSO, is required to complete the "Report of Injury to Employee Form" within 24 hours of the injury and give it to the MSO.
6. The MSO will forward all injury report forms to the Campus Business Services Office and EH&S as specified in the Worker's Compensation Claim Report Procedure.

All forms may be obtained from the Campus Business Service Office at x4440, from the HCC, or from the MSO.

Procedures for Correcting Unsafe or Unhealthy Conditions
Whenever an unsafe condition is discovered the Laboratory Development Engineer, the Principal Investigator, and/or the HCC should take timely steps to mitigate or eliminate the hazard.

If the unsafe condition poses an immediate hazard to life or health the affected area must be evacuated.

If the unsafe condition does not pose an immediate threat, it should be mitigated through improved training, improved procedures, engineering controls, alternative materials, administrative controls, and/or personal protective devices.

Safety & Health Training
Each supervisor is responsible to see to it that all employees under their direction have received appropriate training for the assigned tasks. Each supervisor must also document that such training has occurred.

It is most important that each employee hear their supervisor say that they truly expect the employee to work in a safe and environmentally responsible way even if that requires that work will take more time and/or cost more money.
Sec. I: Laboratory-specific Chemical Hygiene Plan

Record Keeping & Documentation
The MRL HCC and MSO will see to it that records are kept of safety training, laboratory inspection, and actions taken in response to laboratory inspections.

Hazard Communication Program
Most of the requirements for the HCP are covered in the IIPP above. Additional policies of the MRL follow.

Individual supervisors have the primary responsibility for implementing and assuring compliance with the HCP within their work areas. Usually the supervisor will be the Principal Investigator.

The primary focus of the program is to identify all hazardous substances used in the workplace and to identify those employees who may be exposed to hazardous substances so that appropriate training and mitigation occurs and accidents are avoided.

Each supervisor is responsible to identify those work areas and procedures which involve the potential use of or exposure to hazardous substances; and ensure that all employees in those areas are fully aware of the specific hazards and mitigation measures.

All hazardous substances used in each work area are to be identified and inventoried. A paper copy of the full inventory will be posted on or near the Safety Bulletin Board. Digital copies will be available from the HCC to MRL personnel or other responsible parties on request.

Material Safety Data Sheets for all chemicals used in the workplace are to be available for any employee to review at the Hazard Communication Coordinator's office. Such review may be over the Internet. The MRL acknowledges that MSDSs are required by law and are often technically deficient, therefore, other chemical safety reference data shall be kept at the HCC's office.

All employees using or potentially exposed to hazardous substances shall be trained in working safely with those hazards. New employees must be trained prior to their beginning work with the materials. Existing employees must be trained regarding the introduction of new hazardous materials into the workplace prior to using new hazardous materials. Such training may consist of verbal instructions, safety classes, reading assignments, group discussions, or other activity as assigned by the supervisor. The training shall include the following:

1. That the Department's written Hazard Communication Program, Injury and Illness Prevention Program, and Emergency Action Plan are posted near the Safety Bulletin Board and that they may be obtained from the HCC.
2. Physical and health effects of the hazardous substances to which employees may be exposed.
3. Methods and techniques (e.g., instrumentation) used to determine the presence of hazardous substances.
4. Protective measures to be implemented (e.g., work practices, personal protective equipment).
5. Emergency and first aid procedures.
6. How to read and evaluate an MSDS or labels to properly understand appropriate hazard information. How to find and use other chemical safety references.
7. Requirements of the Hazard Communication Regulation (California Code of Regulations Title 8, General Industry Safety Order 5194). Employees shall learn about this when attending EH&S's Laboratory Safety Training.

There shall be no unlabeled containers of chemical substances allowed in the workplace. All containers must be labeled minimally with the following:

1. Name of the contents in written English, chemical symbols are not enough
2. Appropriate hazard warnings
3. The name of the person who purchased or uses the chemical
4. The expiration and target disposal date, if appropriate.

Likewise any tubing or piping carrying hazardous materials must be labeled with at least the name of the material.

Outside contractors working at the MRL must be informed about any potential chemical or physical hazards to which their workers may be exposed.
Appendix F: Other Resources

http://www.mrl.ucsb.edu/general-safety-guidelines

UCDavis SafetyNet: http://safetyservices.ucdavis.edu/snfn/safetynets

- Identification and Segregation of Chemical Waste

- Peroxide Formation in Chemicals
  https://safetyservices.ucdavis.edu/safetynet/peroxide-formation-chemicals

- Guidelines for Disposal of Chemical Waste

- Compressed Gas Safety

- Nanotechnology: Guidelines for Safe Research Practices
  https://safetyservices.ucdavis.edu/safetynet/nanotechnology-guidelines-safe-research-practices

- Safety Precautions for Cryogenic Liquids
  https://safetyservices.ucdavis.edu/safetynet/safety-precautions-cryogenic-liquids

- Procedures for Safe Use of Pyrophoric/Water Reactive Reagents
  https://safetyservices.ucdavis.edu/safetynet/procedures-safe-use-pyrophoricwater-reactive-reagents

- Safe use of Nitric Acid
  https://safetyservices.ucdavis.edu/safetynet/safe-use-nitric-acid

- Guidelines for the Selection of Chemical-Resistant Gloves
  https://safetyservices.ucdavis.edu/safetynet/guidelines-selection-chemical-resistant-gloves

I-63
Sec. I: Laboratory-specific Chemical Hygiene Plan

CHEMICAL HYGIENE PLAN: CERTIFICATION PAGE

Laboratory PI or Supervisor Name:

Applicable Laboratory Location(s) (Buildings /Rooms):

Date of Last Review of Chemical Hygiene Plan with Standard Operating Procedures:
(OSHA mandates Plan be updated as needed, but with minimum of annual review)

Laboratory PI or Supervisor Signoff (required). I certify that I have reviewed and approve the attached Laboratory-specific Chemical Hygiene Plan with Standard Operating Procedures for my above laboratory locations.

Signature: ________________________________

(This page and the next page will probably need periodic updates with signatures. Therefore, it may be preferable to maintain separate hard copies of these two pages.)
Sec. I: Laboratory-specific Chemical Hygiene Plan

Principal Investigator/Supervisor: ________________________________

The following lab workers have reviewed and understand the following elements of the attached Chemical Hygiene Plan for the above PI or supervisor:

- Sec. I: Laboratory-specific Chemical Hygiene Plan with Standard Operating Procedures
- Sec. II: UC/UCSB Policies, Procedures and Resources

<table>
<thead>
<tr>
<th>Name (print)</th>
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## SECTION II: UCSB Chemical Hygiene Plan

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
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</thead>
<tbody>
<tr>
<td><strong>Introduction:</strong> UC/UCSB Policies, Procedures and Resources</td>
<td>2</td>
</tr>
<tr>
<td>Emergency Preparedness and Response</td>
<td>3</td>
</tr>
<tr>
<td>Personal Protective Equipment</td>
<td>6</td>
</tr>
<tr>
<td>Laboratory Safety Training</td>
<td>11</td>
</tr>
<tr>
<td>Chemical Safety</td>
<td>12</td>
</tr>
<tr>
<td>Inspections and Outreach Programs</td>
<td>22</td>
</tr>
<tr>
<td>Waste Disposal</td>
<td>23</td>
</tr>
</tbody>
</table>

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Section II addresses the campus policies, procedures and resources which are core/universal and apply to most labs. In order to free lab supervisors from independently having to address these issues in their Chemical Hygiene Plans (CHP), they are provided herein. In Section 1 laboratory-specific issues/SOPs are addressed.

The information here is a formal part of the UCSB Chemical Hygiene Plan. Therefore, all lab personnel are responsible for being familiar with this information and following the prescriptions therein as they apply to their work. Almost all of the issues addressed herein are based on current regulations and codes, from Cal-OSHA; Cal-EPA; CA Fire Code, etc.

Addressing Non-Chemical Hazards
The CHP Standard requires the addressing of chemical safety issues, but not other lab hazards. For example, biological and radiological hazards, electricity, high/low temperature and pressure, etc. Therefore, those issues are largely not addressed in this CHP, but instead are referenced:

- Via the links in the Introduction section, e.g., Radiation Safety Program; Biological Safety Program. These areas have their own requirements addressed therein.

- Via links (pg. II-16) in this section to selected pages of the free reference: Prudent Practices in the Laboratory, from the National Research Council. This reference is widely recognized as a definitive reference on lab safety and all researchers are strongly encouraged to bookmark its location or buy a hardcopy for their areas.

Researchers are however encouraged to address non-chemical hazards in the lab-specific of their CHP (Sec. 1) via SOPs or protocols.

Minors in Laboratories and Shops:
A UC policy describes the limitations on minors working in these campus areas. A summary of the policy can be found here. The lab supervisor/PI has the primary responsibility for following this policy in their areas.

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The primary informational tool for response to campus incidents is the **UCSB Emergency Information Flipchart** pictured below. This document should already be posted in, or near, every laboratory, as well as in many offices. A Spanish version of the flipchart is available.

The last page (at right) should already be customized to include your local building information—such as the locations of the following: your building’s Emergency Assembly Point, fire extinguishers and fire alarm pull stations, first-aid kits, Automated External Defibrillators, etc. If it is not customized contact your local Department Safety Rep. Please familiarize yourself with the layout and general content of the flipchart. It can also be viewed online.

Power outages in labs are of particular concern – preparing for them and what to do during and afterwards. A fact sheet with some basic guidelines can be found [here](http://www.ehs.ucsb.edu/labsafety-chp).
You should NOT clean up a spill if:
- You don’t know what the spilled material is
- You lack the necessary protection or equipment to do the job safely
- The spill is too large to contain
- The spilled material is highly toxic
- You feel any symptoms of exposure

Instead contact: x3194 EH&S (24 hr line – after-hours may have to wait up to 30 min for response to campus).  OR, if immediately health-threatening call 911 (campus phone)

Spill Response Scheme:

Evaluate and Notify
- Assess the toxicity, flammability, or other properties of material (see label & MSDS)
- For flammables, remove or turn off ignition sources such as motors, pumps, fridges.
- Determine if there is an immediate health threat to you or your neighbors. If so, alert neighbors, isolate the area and call for help using the phone numbers above.
- If spill is minor, begin cleanup following steps below

Containment/Cleanup
- Don appropriate gloves, eye protection, lab coat, etc.
- Per SDS use absorbents* (e.g., “spill pillows” for solvents), or neutralizers appropriate for the material*, e.g. sodium bicarbonate for acids, citric for bases.
- Protect floor drains with absorbents or barriers around them
- Package and label waste. Include contaminated clothes, rags, equipment, etc.
- Store temporarily in a fume hood if material is volatile

Followup
- Send Hazardous Materials/ Waste Pickup Request form to EH&S
- Reorder and restock cleanup materials used
- Inform EH&S if there were any personnel exposures, or release to the environment

*Self-help spill cleanup equipment are available using graduate keys in some buildings.
Fire Extinguishers: Typically by the lab exit door and are the ABC variety (for flammable liquids/paper & wood/electrical, but not for flammable metals). EH&S conducts hands-on extinguisher training for most who attend the EH&S Fundamentals of Laboratory Safety class. There is also an online “refresher” extinguisher tutorial/video that individuals can complete who have already taken the live hands-on training. All campus individuals are strongly encouraged to view the refresher training when needed.

**Online Fire Extinguisher Usage Refresher Training:**
[UC Learning Center](http://www.ehs.ucsb.edu/labsafety-chp)

Need “UCSB Net ID” to login. Then search on “fire extinguisher”

First-Aid Kits: Individual laboratories should have their own 1st aid kit nearby in a location known to all. Supplies should be checked regularly. Departmental kits may not be accessible after-hours.

Emergency Showers and Eyewashes

- Know where your nearest unit is – they are typically within the lab, or in the corridor nearby. Units must be accessible always- no items should block access.
- In the case of chemical exposure to eyes or skin, flush the injury for a minimum of 15 minutes. Be sure to leave the eyes open under the water to flush them.
- Showers can also be used to extinguish a fire on an individual, or their clothing
- Consult the Safety Data Sheet (SDS) for material and show it to the doctor/nurse.
- Facilities periodically flushes emergency eyewash stations and showers. Lab personnel are urged to flush the eyewashes at least monthly as a precautionary measure. Call Facilities at x2661 if you have concerns regarding a specific unit.
- Eyewashes are plumbed with potable water - unlike the rest of the laboratory which is often on "industrial water"- and is considered safe to use on your body.
- Many eyewash/shower units are not equipped with a floor drain. This is because they are so infrequently used that they did not justify the cost of a drain when the building was constructed. Also, it is illegal to flush materials down the drain.
UC Policy on Laboratory Personal Protective Equipment (PPE)

In 2014, UC instituted a policy on the use of PPE in labs. The policy is intended to help protect lab workers from injury, meet Cal-OSHA requirements and bring more consistency to UC PPE practices. All members of the lab community have responsibilities under the policy and the law - particularly supervisors and lab workers.

The most important aspects of the policy are when and where individuals must wear long pants, closed-toe shoes, safety eyewear and a lab coat. This is summarized on a poster which is mounted at the main door to all labs – see next page.

Other Policy Aspects:

- **Exemptions** from wearing PPE (policy requires written exemption from EH&S)
  - hazardous materials/processes-free areas
  - areas protected by adequate distance (some desk locations are problematic)
  - lab areas/desks protected by adequate physical shielding

- Supervisors shall perform a **written assessment** of workplace to determine what PPE is needed – OSHA requirement. This is done via use the online **UC Laboratory Hazard Assessment Tool** (“LHAT“). The assessment should be updated and re-certified by at least every 3 years, or more often if needed. See pg. II-8.

- Supervisor assures **workers are trained** on when PPE is needed and how to wear, adjust & maintain. Per pg. II-8, use the LHAT to receive the necessary documented training for basic lab coat and safety eyewear use.

- Laboratory coats shall not be **laundered** at private residences, or public laundry facilities. See pg. II-8 for free lab coat laundering program details.

- Safety eyewear must meet **American National Standards Institute** standards. Typical prescription spectacles do **not** meet these standards (are not shatter-proof polycarbonate) unless specifically provided by an eye care professional. Safety goggles that readily fit over glasses are provided free (see pg. II-8).

- **Teaching courses** which include lab/shop/field work are required to indicate PPE requirements in the course syllabus or manual. The PPE requirements for teaching labs are **the same as for research labs**. The instructor of record for the course, or designee, is responsible for determining the appropriate PPE and ensuring that students are familiar with and properly use PPE. However, since teaching labs do not go through the LHAT process above, the instructor is responsible for determining which type of safety eyewear are necessary – [click here](http://www.ehs.ucsb.edu/labsafety-chp) for guidance.
Revised 1/2018. OSHA requires that Chemical Hygiene Plans be reviewed and updated annually. So, your copy should have a revision date of less than one year old. Latest version at: http://www.ehs.ucsb.edu/labsafety-chp

Posted at main doorway to each campus lab

**U.C. PERSONAL PROTECTIVE EQUIPMENT POLICY**

**THE BASICS:**
- Minimum PPE for Entering a Laboratory Area: **Long Pants and Closed Toed Shoes**
- PPE While Manipulating Hazardous Materials/Processes: **Appropriate Lab Coat and Safety Eyewear**
- PPE While Adjacent to the Manipulation of Hazardous Materials/Processes: **Same PPE as Those Doing the Work**

**ADDITIONAL PPE AS DETERMINED BY LHA/T AND SOP’S:**

**Face Shield**
- Consider use when handling:
  - Hazardous liquids with a splash hazard
  - Pyrophoric, water reactive or potentially explosive chemicals
  - Cryogenic liquids
  - High pressure or vacuum systems

**Splash Goggles**
- Use when handling:
  - Hazardous liquids when >4L or with a splash hazard
  - Corrosives when >4L
  - Cryogenic or scalding liquids when >4L

**Gloves**
- Use appropriate gloves when handling:
  - Hazardous, toxic or corrosive chemicals, engineered nanomaterials, unsealed radioactive materials
  - Cryogenic liquids or dry ice
  - Biohazards (double glove for BSL-2 or greater)

**Chemical Resistant Apron**
- Use when handling:
  - Minor spill clean-up
  - Corrosives >4L

**Consider when handling:**
- Hazardous liquids w/splash hazard
- Acutely toxic chemicals
- High pressure or vacuum systems

See full PPE policy, LHA/T, and your lab SOP’s for more details. Additional requirements may apply as determined by the campus biosafety, radiation and animal care committees.
To facilitate the policy summarized on pg. II-6, UC provides the following resources:

1. The online Laboratory Hazard Assessment Tool (“LHAT”) [https://ehs.ucop.edu/lhat/] is for supervisor’s to do PPE assessments for their workers. The LHAT can only be accessed via an individual’s UCSB NetID and password. Per UC policy, the LHAT assessment must be re-certified/revised online at least every 3 years, or more often if changes occur. Contact EH&S for assistance.

2. For lab workers, the LHAT provides a summary of the lab’s PPE needs and provides/documents training on basic lab coat and eyewear use and maintenance.

3. Free laboratory coats (3 types for different hazards), safety eyewear and communal face shields and lab aprons – see below. [Use & Limitations] of UC-provided PPE.

4. Free lab coat laundering services – see below.

Obtaining Free PPE: After the lab supervisor completes the LHAT process, their workers login to the LHAT to review the assessment results, watch a short training video, take a short quiz and print out a “PPE voucher”. With the voucher they may pick-up two free lab coats and eyewear at the Graduate Storeroom in the Dept. of Chemistry & Biochemistry (Bldg. 557, room 1432). Short-time lab workers may receive a “loaner” coat they return.

For the many short-term summer intern lab workers each year, the procedure for obtaining their PPE is generally different – [click here]

Lab Coat Laundry Service: There are seven sites on campus for workers to drop off their dirty lab coats for laundering and pick-up when clean. Each coat will be marked with the coat’s unique identifier number and the individual’s name. Your cleaned coat will be returned to the one site that you designate – [FAQs]. Lab coats and safety eyewear which are no longer needed should be recycled for reuse by placing in the separate designated bins at one of the seven sites noted above.

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Use of respirators is highly regulated by Cal-OSHA (CCR, Title 8, 5144). Per the UCSB Respiratory Protection Policy (5440), all use of respiratory protection equipment (including filtering facepiece respirators (dust masks) must be reviewed and approved by EH&S. Fortunately, a respirator is typically not needed in a laboratory to reduce/eliminate exposures. Under most circumstances, safe work practices and engineering controls (e.g., fume hoods) adequately protect workers. Under certain circumstances, however, respiratory protection may be needed as determined by EH&S. These can include:

- Chemical spill outside the fume hood, or spill of biohazard outside a biosafety cabinet
- An unusual operation that can’t be conducted in fume hood or biosafety cabinet
- Weighing powders outside a glove box or other protective enclosure. Disposable filtering face-piece respirators are generally recommended for nuisance dusts.
- When monitoring shows that exposures exist that cannot be otherwise controlled
- As required by a specific laboratory protocol or as defined by applicable regulations

If you believe respiratory protection equipment may be necessary, or if an individual would like to wear equipment voluntarily, please contact the UCSB Respiratory Protection Program (x-3743, x-8787, or rpp@ucsb.edu) for review and approval. There is a wide variety of respiratory protection equipment available, and each has specific applications, limitations and use requirements. It is extremely important that equipment is selected and used properly, to ensure that the respirator itself does not create an additional hazard.
The correct gloves protect against chemicals; the wrong gloves enhance chemical contact. There is no universal glove that protects you from all chemicals. To choose the correct glove, go to a Glove Reference Chart - links below. Chlorinated solvents are carcinogenic and are particularly challenging to find appropriate gloves for.

**All gloves are permeable**, only the permeation rate varies, depending on the chemical, the glove material and thickness, temperature, concentration gradient, etc. However, once a material begins to permeate the glove, it will continue until an equilibrium is reached. You must, therefore, decide when it is appropriate to discard dirty gloves.

**Check gloves** before use for signs of wear or penetration. Disposable gloves can be inflated to check for pinholes. When removing gloves, be careful to avoid touching the outside of the gloves with your bare hands. Always remove gloves before leaving lab.

**Disposable gloves** provide minimal protection and should be used accordingly. If using concentrated solvents, corrosives or toxics, more heavy-duty gloves should be worn. These provide more protection, but have the drawback of being more cumbersome. Note also that about 15% of the population is allergic to latex to some degree.

**Gloves for Handling Pyrophorics**: These chemicals *spontaneously ignite in air*, but are only found in a few departments. Having the proper glove is important to avoid injury from a burning/melting glove. *Per a legal Agreement between UC and Cal-OSHA, all lab workers who handle pyrophorics outside of an inert gas glove box, must use special non-combustible gloves for handling pyrophorics.* In 2016 these gloves were provided free for affected groups and they received special training from EH&S. Free gloves will be provided while funding lasts. An online training for new workers in these groups is available on the UC Learning Center (search on “Pyrophoric”) and all such workers must take this training, or request live training from EH&S.

**Glove Reference Charts** *(No guarantees are made regarding the accuracy of these charts. Recommend cross-checking at least two sites for consistency.)*

- [Microflex Chemical Resistance Guide](#)
- [Cole-Parmer](#)
- [Ansell Chemical Resistance Guide](#)
UC Policy on Laboratory Safety Training

Documentation of occupationally-related safety training is a legal requirement under Cal-OSHA. In 2013, UC adopted a new policy entitled: Laboratory Safety Training to satisfy OSHA and improve safety awareness. Lab supervisors/departments have clear and direct responsibilities under the policy and the law. There are two primary requirements of the policy:

1. All “lab workers” complete a Fundamentals of Laboratory Safety orientation (live or online) in order to be given access to their lab(s) by their department. Enrollment directions are given below. The trainings are generic and do not address the specific hazards/procedures for a particular lab. Supervisors/PIs are still responsible under the law for ensuring this has been provided – see #2. The fundamentals training covers the core issues common to most/all labs and addresses many specific regulatory training requirements.

   **Accessing the Fundamentals of Laboratory Safety Orientations (mandatory per UC policy)**
   - **Live Version:** 3-hour, instructor-led training is offered regularly - generally once per quarter. Enroll via the UC Learning Center using UCSB NetID*. Search on “LS01”. This training is more in-depth than the online version below and generally includes hands-on fire extinguisher training.
   - **Online Version:** Available via the UC Learning Center using UCSB NetID*. Search on “LS60”

   *note that undergraduate UCSB NetIDs do not work directly in the UC Learning Center, but follow the instructions therein for undergraduate enrollment procedures.

2. Lab-specific training is addressed in the second major policy mandate. The UC policy requires a Training Needs Assessment (TNA) pdf / Word to be performed for each lab worker. The form is electronically forwarded when the worker attends the Fundamentals class above. The worker is instructed to work with their supervisor, or designee, to complete the assessment and document completed training on the form (or elsewhere). The form categorizes training into 3 areas:
   a. “Day One” lab orientation (e.g., location of emergency equipment, issue PPE, etc.)
   b. Other EH&S formal classes, if needed (e.g., radiation safety, biosafety, etc.)
   c. Other lab-specific training (e.g., local protocols, hazards, etc.)

The TNA is also a good tool for labs to use in “on-boarding” new workers since it lists all the basic health and safety tasks to cover with a new lab worker.

Revised 1/2018. OSHA requires that Chemical Hygiene Plans be reviewed and updated annually. So, your copy should have a revision date of less than one year old. Latest version at: http://www.ehs.ucsb.edu/labsafety-chp
Under OSHA, there are 500+ chemicals that have airborne chemical concentration limits known as Permissible Exposure Limits (PEL). Legally, you cannot be exposed above these limits. PELs are expressed in parts per million (or mg/m³) in air. PEL values can be for 15 minute or 8 hour exposure periods, or ceiling limits which should never be exceeded. A smaller table of PEL values for ~50 common lab chemicals is available.

Typically, if these materials are used in a fume hood and proper PPE is utilized, per this manual, then there is little reason to believe exposure levels are a concern. If you believe exposure limits may be exceeded, contact EH&S to schedule an exposure assessment. If exposure limits are exceeded, additional steps must be taken to reduce. EH&S does do occasional quantitative exposure monitoring of targeted operations to confirm acceptable exposure levels.

**Human Carcinogens**

Of the 500 materials noted above, some are carcinogens which are further/highly regulated under separate OSHA safety standards. They are separated into two classes:

- **Regulated Carcinogens** fall into a higher hazard class and have extensive additional OSHA requirements associated with them. There are 30 in this category, but the common ones found in the lab are formaldehyde, methylene chloride and benzene. It is important to effectively apply safety controls as the regulatory requirements for laboratories that exceed threshold values for these chemicals are very extensive.

- **Select Carcinogens** are defined under the OSHA Lab Safety Standard as follows.
  
  - Regulated Carcinogens (see above)
  - *Annual Report on Carcinogens* published by the *National Toxicology Program*: all of the substances listed as "known to be carcinogens" and some listed as "reasonably anticipated to be carcinogens"
  - *International Agency for Research on Cancer*: all of Group 1 "carcinogen to humans" materials; and some in Group 2A/B.
Safety Data Sheets (SDS, formerly known as MSDS)

What is a Safety Data Sheet?  SDS – formerly known as Material Safety Data Sheets - are a summary of the health hazards of a chemical material and associated recommended safe work practices. SDS are required by OSHA under the Lab Safety Standard and Hazard Communication Standard to be made readily available by chemical vendors to the purchasers of their chemicals. The use and relevance of SDS are covered in the mandatory EH&S Fundamentals of Laboratory Safety class. If you work in a lab, then OSHA says you must:

- be aware of what an SDS is and their relevance to your health and safety
- be aware of how to access SDS for your work area
- maintain SDSs that are received with incoming chemical shipments and ensure that they are readily accessible to lab employees during each work shift when they are in their work area(s). Electronic access per below is acceptable with a printer.

(M)SDS Sources:

Google Customized SDS Search

Laboratory Chemical Safety Summaries (not SDS, but quality info aimed at labs)

Fisher Scientific

SIRI

Sigma-Aldrich SDS

Matheson’s Gases
Chemical Labelling

Under the Cal-OSHA Hazard Communication Standard (CCR, Title 8, 5194) all chemical containers must be properly labeled – unless a material is temporarily put into a new container for immediate use and is not going to be stored after that immediate use. Labeling requirements for all hazardous substances are summarized as follows:

General requirements
- All containers of hazardous materials must be labeled with the identity of the hazardous substance
- The label must contain all applicable hazard warning statements, e.g. flammable, carcinogen, corrosive

For commercial materials in the original vendor’s container
- Manufacturer’s product labels must remain on all containers, and not be defaced

For materials repackaged in the laboratory
- Labels must be legible, in English, and provide the info above under general requirements
- This includes secondary containers (such as spray bottles and acid/base baths) and must be labeled as above
- New synthesized compounds, or commercial products that are repackaged, must be labeled with the appropriate hazard warnings based on the knowledge of the chemical and physical properties of that substance.

In 2012 Cal-OSHA adopted use of the Globally Harmonized System (GHS) of chemical classification and labeling which supersedes earlier systems. Employees using chemicals need to be trained on the new system. On the next page is a summary of the terms used in the system: Hazard Statements, Hazard Classes, Signal Words and Pictograms, etc. Campus workers should familiarize themselves with the basic aspects of this system as they will see these terms used on all containers they receive from vendors.
# Pictograms and Hazard Codes Used in the Globally Harmonized Chemical Labeling System

All chemical containers provided by vendors will eventually use the following labeling system. Per Cal-OSHA employees need to be familiar with the labeling system and its relevance to the hazards of hazardous materials.

<table>
<thead>
<tr>
<th>Description</th>
<th>Pictogram</th>
<th>Hazard class and hazard category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exploding Bomb</strong>&lt;br&gt;GHS01</td>
<td><img src="exploding_bomb.png" alt="Pictogram" /></td>
<td>Unstable explosives&lt;br&gt;Explosives of Divisions 1.1, 1.2, 1.3, 1.4&lt;br&gt;Self-reactive substances and mixtures, Types A,B&lt;br&gt;Organic peroxides, Types A,B</td>
</tr>
<tr>
<td><strong>Flame</strong>&lt;br&gt;GHS02</td>
<td><img src="flame.png" alt="Pictogram" /></td>
<td>Flammable gases, category 1&lt;br&gt;Flammable aerosols, categories 1,2&lt;br&gt;Flammable liquids, categories 1,2,3&lt;br&gt;Flammable solids, categories 1,2&lt;br&gt;Self-reactive substances and mixtures, Types B,C,D,E,F&lt;br&gt;Pyrolytic liquids, and solids, category 1&lt;br&gt;Self-heating substances and mixtures, categories 1,2&lt;br&gt;Substances and mixtures, which in contact with water, emit flammable gases, categories 1,2,3&lt;br&gt;Organic peroxides, Types B,C,D,E,F</td>
</tr>
<tr>
<td><strong>Flame Over Circle</strong>&lt;br&gt;GHS03</td>
<td><img src="flame_over_circle.png" alt="Pictogram" /></td>
<td>Oxidizing gases, category 1&lt;br&gt;Oxidizing liquids, categories 1,2,3</td>
</tr>
<tr>
<td><strong>Gas Cylinder</strong>&lt;br&gt;GHS04</td>
<td><img src="gas_cylinder.png" alt="Pictogram" /></td>
<td>Gases under pressure:&lt;br&gt;- Compressed gases&lt;br&gt;- Liquefied gases&lt;br&gt;- Refrigerated liquefied gases&lt;br&gt;- Dissolved gases</td>
</tr>
<tr>
<td><strong>Corrosion</strong>&lt;br&gt;GHS05</td>
<td><img src="corrosion.png" alt="Pictogram" /></td>
<td>Corrosive to metals, category 1&lt;br&gt;Skin corrosion, categories 1A,1B,1C&lt;br&gt;Serious eye damage, category 1</td>
</tr>
<tr>
<td><strong>Skull and Crossbones</strong>&lt;br&gt;GHS06</td>
<td><img src="skull_crossbones.png" alt="Pictogram" /></td>
<td>Acute toxicity (oral, dermal, inhalation), categories 1,2,3</td>
</tr>
<tr>
<td><strong>Exclamation Mark</strong>&lt;br&gt;GHS07</td>
<td><img src="exclamation_mark.png" alt="Pictogram" /></td>
<td>Acute toxicity (oral, dermal, inhalation), category 4&lt;br&gt;Skin and eye irritation, category 2&lt;br&gt;Skin sensitisation, category 1&lt;br&gt;Specific Target Organ Toxicity – Single exposure, category 3</td>
</tr>
<tr>
<td><strong>Health Hazard</strong>&lt;br&gt;GHS08</td>
<td><img src="health_hazard.png" alt="Pictogram" /></td>
<td>Respiratory sensitization, category 1&lt;br&gt;Germ cell mutagenicity, categories 1A,1B,2&lt;br&gt;Carcinogenicity, categories 1A,1B,2&lt;br&gt;Reproductive toxicity, categories 1A,1B,2&lt;br&gt;Specific Target Organ Toxicity – Single exposure, categories 1,2&lt;br&gt;Specific Target Organ Toxicity – Repeated exposure, categories 1,2&lt;br&gt;Aspiration Hazard, category 1</td>
</tr>
<tr>
<td><strong>Environment</strong>&lt;br&gt;GHS09</td>
<td><img src="environment.png" alt="Pictogram" /></td>
<td>Hazardous to the aquatic environment&lt;br&gt;- Acute hazard, category 1&lt;br&gt;- Chronic hazard, categories 1,2</td>
</tr>
</tbody>
</table>
The next few pages deal primarily with “engineering controls”, i.e. fume hoods, gas cabinets, glove boxes, etc. **Engineering controls are considered the “first line of defense” in protecting workers. In contrast, PPE is generally considered the final defense.** The Lab Standard requires that the general criteria for implementing control measures be described. The appropriate engineering control is often obvious, but the general criteria are noted here for the common ones. The criteria should be followed unless equivalent protection can be realized. Specific engineering controls should also be described in a lab’s SOPs.

### FUME HOODS, WET BENCHES, GAS CABINETS & OTHER EXHAUST VENTILATION
- When using volatile substances that present a significant inhalation hazard
- When necessary to keep exposure levels below OSHA Permissible Exposure Limits
- When using toxic gases, particularly when required by the CA Fire Code
- When indicated in Standard Operating Procedures, or as indicated in SDS

### BIOSAFETY CABINETS
- With operations involving biohazardous material as directed by NIH and CDC guidelines, or the OSHA Bloodborne Pathogens Standard
- When stipulated by the Biohazard Use Authorization
- When indicated in Standard Operating Procedures

### GLOVE BOXES
- When indicated in Standard Operating Procedures

### APPROVED HAZARDOUS MATERIALS STORAGE CABINETS AND SAFETY CANS
- Whenever possible, but particularly when CA fire code volume limits are exceeded
- When indicated in Standard Operating Procedures

### FLAMMABLE STORAGE REFRIGERATORS (APPROVED-TYPE)
- When refrigerated storage of flammable materials is needed
Within UCSB labs exists a great diversity of research and associated hazards. To address this diversity and simultaneously reduce the length of this document, we have provided links below to selected sections of *Prudent Practices in the Laboratory* by the National Resource Council (2011). This free text is widely considered to be the definitive publication on general lab safety. The sections selected here are those dealing with the *generic* management of hazardous materials/operations. In contrast, the other sections of this CHP are more related to issues that are UC or UCSB specific, or Cal-OSHA driven.

### 4 Evaluating Hazards and Assessing Risks in the Laboratory

4.A Introduction
4.B Sources of Information
4.C Toxic Effects of Laboratory Chemicals
4.D Flammable, Reactive, and Explosive Hazards
4.E Physical Hazards
   - Compressed Gases
   - Nonflammable Cryogens
   - High-Pressure Reactions
   - Vacuum Work
   - Ultraviolet, Visible, and Near-Infrared Radiation
   - Radio Frequency and Microwave Hazards
   - Electrical Hazards
   - Magnetic Fields
   - Sharp Edges
   - Slips, Trips, and Falls
   - Ergonomic Hazards in the Laboratory
4.F Nanomaterials
4.G Biohazards (see also, *UCSB Biosafety Program*)
4.H Hazards from Radioactivity (see also, *UCSB Radiation Safety Program*)
5 Management of Chemicals

5.A Introduction
5.B Green Chemistry for Every Laboratory
5.C Acquisition of Chemicals
5.D Inventory and Tracking of Chemicals
5.E Storage of Chemicals in Storerooms and Laboratories

6 Working with Chemicals

6.A Introduction
6.B Prudent Planning
6.C General Procedures for Working with Hazardous Chemicals
6.D Working with Substances of High Toxicity
6.E Working with Biohazardous and Radioactive Matls (see UCSB programs)
6.F Working with Flammable Chemicals
6.G Working with Highly Reactive or Explosive Chemicals
6.H Working with Compressed Gases
6.I Working with Microwave Ovens
6.J Working with Nanoparticles

7 Working with Laboratory Equipment

7.A Introduction
7.B Working with Water-Cooled Equipment
7.C Working with Electrically Powered Laboratory Equipment
7.D Working with Compressed Gases
7.E Working with High or Low Pressures and Temperatures
7.F Using Personal Protective, Safety & Emerg. Equipment (also pgs. II-6 to 10)
7.G Emergency Procedures (see also pgs. II-3 to 5)
Fume Hood Usage Guide: Standard Hoods

(“Standard” hoods do not have the “VAV control box” shown on the next page)

Per Cal-OSHA, users of hoods must be trained on use of their hood. Attendance at the live or online lab safety orientations described below on the “UC Policy on Laboratory Safety Training” page satisfies that requirement. The information on this page should also be read by all hood users and is posted on campus hoods for easy reference.

Always work with the sash at, or below, the level of the red arrow sticker (picture on next pg.) and close it when not attended. To adequately protect you, your hood should be producing a face velocity of about 100 ft/min. EH&S tests your hood and posts the red arrow stickers at the proper sash level to:

- satisfy the required air flow and protect you against airborne chemicals
- protect you better from incidents within the hood
- *All hoods on campus are equipped with an air flow monitor and/or alarm to warn you if the air velocity is too low – pictured below. If the alarm engages, lower the sash slightly until the alarm stops. Do NOT disengage or over-ride the alarm. If your alarm sounds consistently this could indicate a real problem – call EH&S.
- Always work at least 6 inches inside the hood to maximize capture efficiency and store only a minimum of equipment and chemicals in your hood because:
- Excess materials will block the air flow into the intake slots at the back of the hood. Permanent equipment should be raised on a jack to allow the air to flow smoothly.
- Most fires and explosions occur in the hood. Minimizing chemical volumes will reduce the chances of a small accident escalating into a large one.
- Keep the lab windows closed. Drafts from open windows and doors can significantly affect your hood’s performance (100 ft/min is only a few miles/hr of air).

![Image of red arrow sticker](image1)

*“Magnihelic gauge” – note normal gauge position. Significant deviation may indicate low air flow.

![Image of VAV control box](image2)

*Visible/audible alarm Sounds during low-flow condition of low air flow.

Revised 1/2018. OSHA requires that Chemical Hygiene Plans be reviewed and updated annually. So, your copy should have a revision date of less than one year old. Latest version at: http://www.ehs.ucsb.edu/labsafety-chp
Fume Hood Usage Guide: Variable Air Volume Hoods ("Phoenix" system)

Per Cal-OSHA regulations, users of hoods must be trained on use of their fume hood. Attendance at the live or on-line lab safety orientations described below on the “UC Policy on Laboratory Safety Training” page satisfies that requirement. The information on this page should also be read by all hood users and is posted on all hoods.

- Variable Air Volume (VAV) hoods — unlike a standard hood above — automatically adjust the face velocity to stay within safe work levels (~ 100 ft./min). A VAV hood is easily distinguished by the gray control box on the hood - picture below.
- **If the low-flow alarm engages, lower the sash until the alarm stops.** DO NOT over-ride the safety alarm by permanently engaging the "Mute" or "Emergency" button (e.g., with tape). If your hood is consistently alarming call EH&S (x-4899).
- Always work with the sash at or below the level of the **red arrow sticker** (below), because, if most bldg. sashes are raised, this will generate a hood alarm, and at your neighbor’s hood, due to the limited capacity of your building’s ventilation.
- A lowered sash protects you against airborne chemicals and incidents better than at sash full open.
- The lower the sash, the greater the **energy savings** – lower sash when not in use
- Store only the minimum of equipment and chemicals in your hood because:
  - Excess materials block air flow into the slots at back of the hood. Permanent equipment should be raised on a stand to allow good air flow
  - Most lab fires/explosions occur in hoods. Minimizing chemical volumes will reduce the chances of a small accident escalating into a large one.
- Always work at least 6 inches inside the hood to maximize hood capture efficiency.

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**Refrigerators and Freezers in Labs**

Certain refrigerator/freezer units are designed specifically for the storage of flammable materials, and to prevent potentially explosions. This is critical, since flammable vapors coupled with an ignition source could result in an explosion. In other words, a normal kitchen refrigerator is not safe for the storage of chemicals. Before purchasing a new unit, or using an existing one, consider if chemicals will be stored there. Note that many lab refrigerators will be around for decades and so one cannot guarantee that a normal unit will never be used for flammables storage.

**FLAMMABLE MATERIAL STORAGE REFRIGERATORS/FREEZERS:**

These have no internal electrical components which could trigger an explosion. These must always be used for storage of volatile materials. Also known as “lab-safe” or “de-sparked” refrigerators.

All refrigerator/freezer purchases and modifications on campus must be pre-approved by EH&S at X8243. In addition, all approved units for storing flammable materials must be labeled with signage reading, “Approved For Chemical Storage, No Food Storage”. All refrigerator/freezer units not approved for storage of flammable materials must be signed as “Explosion Hazard”, or equivalent. Contact EH&S for your free labels.

Examples of signage on campus lab refrigerators

UCI refrigerator which exploded when chemicals were stored in a unit which was not designed for flammables
EH&S Laboratory Inspection and Lab Outreach Programs

EH&S inspects all lab spaces on campus at least annually. However, it is strongly recommended that labs initiate periodic self-inspections (recommend minimum of twice-a-year).

Prior to the EH&S visits a Self-Inspection Checklist is generally distributed to aid laboratories in establishing their own audits. The list does not include every possible safety issue, but are general guidelines. Most items are based on applicable regulations or UC policy. Radiation and biohazard issues are not addressed in the checklist because they are highly specialized and these labs receive targeted EH&S visits.

In 2017 EH&S instituted a “lab outreach program” in which an EH&S rep contacts each research group for an appointment to meet with a knowledgeable group rep. The sit-downs are generally less than an hour. Due to the large number of new UC lab safety policies/procedures in recent years, it is a good opportunity to review a group’s understanding, answer questions and hear from researchers about their concerns.

For both the EH&S lab inspection and outreach programs, the results are summarized within an online tool known as “UC Inspect”. The app allows for efficient communication and tracking of findings and corrections.
STORAGE

- Store chemical waste in a designated area. Label as, "HAZARDOUS WASTE STORAGE AREA"
- Store chemicals in containers compatible with, and durable enough for, the waste.
- Liquid waste must be in screw-top containers. Do not overfill - allow for expansion.

LABELING

- Identify waste by proper chemical name (no abbreviations or chemical structures).
- List chemical names of hazardous components in that mixture by percent weight
- Deface existing labels when reusing containers
- Label and date container(s) when the first drop of waste is added. Hazardous waste shall be given to EH&S for disposal within nine months of start date.
- Use UCSB HAZARDOUS WASTE label on all waste containers. Available for free – see below.

SEGREGATION: group waste into the following categories:
- halogenated solvents
- acids with pH 2 or less
- alkali metals and other water reactives
- strong oxidizers (e.g., nitric acid)
- unstable chemicals
- non-halogenated solvents
- alkaline solutions of pH 12.5 or greater
- heavy metal solutions and salts
- cyanides

DISPOSAL

- Chemicals may not be disposed in regular trash, sink disposed, or allowed to evaporate.
- Complete a UCSB Waste Pick-up Request Form. Send by campus mail or fax(X8659). Also available on the EH&S website for electronic submission
- EH&S cannot accept responsibility for improperly labeled, packaged, and/or segregated chemicals, and will not pick them up.
- Waste containers become the property of EH&S and will not be returned
"Sharps waste" means any device having acute rigid corners, edges, or protuberances capable of cutting or piercing, including, but not limited to, all of the following: hypodermic needles, syringes, razor blades and scalpel blades. Glass items contaminated with biohazards, such as pipettes, microscope slides and capillary tubes are also a "sharps waste." Under no circumstances should “sharps waste” be disposed of in the normal trash. Sharps must be disposed of through EH&S, or a medical waste management company.

**Laboratory Sharps Disposal**

1. Place in a rigid, puncture-resistant container which, when sealed, is leak proof. Examples below.
2. Label the container with a hazardous waste label and include the chemical constituents.
3. Submit an online Chemical Waste Collection Request via the EH&S website. Please note on the request that the material is not biologically contaminated and deface any biohazard symbols, if present.

**Sharps Contaminated with Hazardous Chemical Waste**

**Sharps Contaminated with Radioactive Materials**

See the EH&S website at this address: [http://www.ehs.ucsb.edu/biosafety/biosafety-guide](http://www.ehs.ucsb.edu/biosafety/biosafety-guide) and see the documents “Biohazards Sharps Use and Disposal” or “Medical Waste Procedures”.

**Sharps Contaminated with Medical or Biohazardous Waste**

1. Place in a rigid, puncture-resistant container which, when sealed, is leak proof. Examples below.
2. Label the container with a radioactive waste label and include the radioactive isotope.
3. Submit an online Radioactive Waste Collection Request via the EH&S website. Please note on the request that the material is not biologically contaminated and deface any biohazard symbols present.

**Unused or Non-Contaminated Hypodermic Needles**

1. Place in an approved biohazardous sharps container that is rigid, puncture-resistant and which, when sealed, is leak proof and cannot be opened without great difficulty - examples below.
2. Deface any biohazard symbols, if present.
3. Submit an online Chemical Waste Collection Request via the EH&S website. Please note on the request that the material is not biologically contaminated.

**Laboratory Glass Disposal**

**Definition:** Laboratory glass is defined as equipment generally made of pyrex, borosilicate, and quartz glass used for scientific experiments. Examples of laboratory glass include, but are not limited to, the following: beakers, flasks, graduated cylinders, stirring rods, test tubes, microscope slides, glass pipettes, glass petri dishes, and glass vials. **Glass items contaminated with biohazards, such as pipettes,**
microscope slides, and capillary tubes are considered “sharps waste”. Under no circumstances should “sharps waste” be disposed of in the normal trash. Sharps must be disposed through EH&S or a certified medical waste management company.

Directions:

- Prior to utilizing the cardboard lab glass box, duct tape the bottom to ensure the container is secure.
- Labs can use a 32gal. red lidded cart to house cardboard lab glass box for ease of transport. (*loose lab glass cannot be placed in red lidded cart*)
- Place unwanted lab glass in the cardboard lab glass box. Non-lab glass, such as beverage containers should be placed in recycling receptacles, and not disposed along with laboratory glass waste.
- When full, use duct tape to secure the lid to the body of the box. Be sure that the lid is securely fastened to the body of the box so the contents remain inside.
- Bring the cardboard lab glass box down to your building’s red lidded carts and place inside. Then lock the cart. If you are using the 32gal. cart to house the cardboard glass box, roll the cart down to the dumpster corral and leave for pick-up. Carts are serviced on Saturdays.

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**Sharps Disposal Basic Flowchart (see above for specific types of hazmat-contaminated sharps)**

![Sharps Disposal Flowchart]

- **Sharps Containers**
  - Small
  - Large
- **EH&S**
- **Medical Waste Management Company**
- **Landfill**

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**Cardboard Lab Glass Boxes**

Carts serviced by MarBorg on Saturdays

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Section III: REGULATORY FRAMEWORK

A. THE CAL-OSHA LABORATORY SAFETY STANDARD

1. Background
2. Applicability
3. Summary of Standard

B. RESPONSIBILITIES

1. Introduction
2. Responsibilities

C. PROGRAM ELEMENTS OF THE CHEMICAL HYGIENE PLAN

1. Employee Information and Training
2. Standard Operating Procedures
3. Particularly Hazardous Substances
4. Criteria for Determination and Implementation of Control Measures
5. Maintenance of Engineering Controls and Emergency Equipment
6. Hazard Identification
7. Prior Approval
8. Medical Consultation and Examination
9. Criteria for Establishing Exposure Monitoring

Revised 1/2018. OSHA requires that Chemical Hygiene Plans be reviewed and updated annually. So, your copy should have a revision date of less than one year old. Latest version at:  http://www.ehs.ucsb.edu/labsafety-chp
A. THE CAL-OSHA LABORATORY SAFETY STANDARD

1. Background

The Standard for Occupational Exposure to Hazardous Chemicals in Laboratories (commonly known as the “Laboratory Standard”, or “Chemical Hygiene Plan”) was adopted by the California Occupational Health & Safety Administration (Cal/OSHA) Standards Board on February 21, 1991. The Standard is summarized on the following page and the complete text is available online.

The intent of the Laboratory Standard is to protect laboratory employees from harm due to chemicals. The design of the Laboratory Standard is based on a recognition by OSHA that laboratory work is typically different in character from industrial operations in their use and handling of chemicals. In contrast to many industrial operations, laboratory chemical work often involves a relatively large number of chemicals in small scale procedures that can change significantly over time to reflect evolving research.

2. Applicability

Labs meeting the following four criteria are subject to the Laboratory Standard:

- Chemical manipulations are on a lab scale, i.e., easily and safely manipulated by one person
- Multiple chemical procedures are used
- Procedures are not part of a production process, nor simulate a production process
- Protective laboratory practices and equipment are available and commonly used

Clearly, most research and teaching laboratories at UCSB, meet these criteria. Students in teaching laboratories are not University employees and therefore do not fall under the provisions of the Standard. However, it is the judgment of the University that, it is obligated to develop policies and course materials which attempt to provide the same level of protection for students. It should be noted that teaching assistants, faculty and staff in instructional labs are covered by the Lab Standard and therefore need to be included in a Chemical Hygiene Plan.

3. Summary of the Laboratory Safety Standard

The Laboratory Standard contains the following elements.

- Chemical Hygiene Plan (CHP)— A written plan (this document) must be developed to control and minimize chemical exposure in laboratories. The CHP must be readily available to affected employees, who need to be oriented to its provisions and relevance to their health and safety. A CHP is required where hazardous chemicals, as defined by OSHA, are used in the workplace. The CHP must be:
  
  (A) Capable of protecting employees from health hazards associated with hazardous chemicals
  (B) Capable of keeping exposures below OSHA Permissible Exposure Limits

Revised 1/2018. OSHA requires that Chemical Hygiene Plans be reviewed and updated annually. So, your copy should have a revision date of less than one year old. Latest version at: http://www.ehs.ucsb.edu/labsafety-chp
• **Responsibilities**— Personnel responsible for implementation of the CHP must be designated, including the appointment of a Chemical Hygiene Officer. [Sec. III.B]

• **Employee Information and Training**— The employer shall provide employees with information and training to ensure that they are informed of the hazards in their work area and their avoidance. [Sec. III.C.1]

• **Standard Operating Procedures**— SOPs must be developed for incorporation into the CHP relevant to safety and health when lab work involves the use of hazardous chemicals. [Secs. I and III.C.2]

• **Particularly Hazardous Substances**— Provisions must be specified for additional employee protection for work with substances such as "select carcinogens", high acute toxicity substances and reproductive toxins. Provisions are generally incorporated into the SOPs. [Secs. I and III.C.3]

• **Control Measures**— Criteria must be established that the employer will use to determine, implement and adequately maintain control measures to reduce employee exposures, including lab ventilation, personal protective equipment. Control measures generally incorporated into SOPs. [Sec. III.C.4]

• **Maintenance of Engineering Controls, Personal Protective Equipment and Emergency Equipment**— fume hoods must comply with Title 8 5154.1 and protective equipment function properly. [Sec. III.C.5]

• **Hazard Identification**— Safety Data Sheets and other reference materials need to be available. Labeling of chemicals is strictly regulated. [Sec. III.C.6.]

• **Prior Approval**— Circumstances must be stipulated under which a particular laboratory operation requires prior approval from the lab supervisor. Generally incorporated into SOPs [Sec. III.C.7]

• **Employee Exposure Determination**— As appropriate, measurements must be taken to verify that exposure limits are not exceeded. [Sec. III.C.9]

• **Medical Consultation and Examinations**— Workers are entitled to medical attention when a significant chemical exposure is suspected. [Sec. III.C.8]
B. RESPONSIBILITIES

a. Management
Department heads, deans, supervisors, vice-chancellors and the chancellor are responsible for ensuring that individuals under their management have the training and authority to implement appropriate health and safety policies and practices relative to the Laboratory Standard and per campus policy #5400.

b. Laboratory Supervisors/Principal Investigators
The term “supervisor” at UCSB refers to anyone having direct supervisory authority, and includes staff administrators, class instructors, research assistants, managers, and faculty. The supervisor is the key individual in a successful lab safety program. Supervisors are responsible for developing and implementing the CHP for their laboratories, particularly the development of appropriate SOPs. A helpful guideline to many common specific tasks of a lab supervisor can be found online. Supervisors can delegate tasks, but cannot delegate their overall responsibility.

c. Environmental Health & Safety (EH&S)
Develop safety education and monitoring programs to help maintain a safe and healthy environment for all, in order to facilitate the research and teaching functions of the University. Support research and instructional activities by developing legally-mandated programs; provide technical guidance and consulting; and assist departments in program implementation. Make every effort to keep operations functioning smoothly in labs.

d. Chemical Hygiene Officer
The Lab Standard specifically calls for the appointment of a 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.” This CHO role at UCSB is now assigned as follows:

- UCSB Departments: Chemistry & Biochemistry; Materials; Chemical Engineering, Electrical and Computer Engineering: Alex Moretto, Chemical Laboratory Safety Officer, Physical Sciences Building North 2660, (805) 893-6630, moretto@chem.ucsb.edu

- All Other UCSB Laboratory Departments/Units: Currently vacant. Contact: Hector Acuna, x-8243.

CHO Duties: develop and distribute the UCSB Chemical Hygiene Plan to laboratory supervisors. Assist and advise faculty and staff in the customization and implementation of their CHP as requested/needed. Describe the provisions of the CHP to those attending the Fundamentals of Laboratory Safety orientations. Monitor and evaluate the effectiveness of the CHP. As a member of the Laboratory Safety Committee, advise campus management on the effectiveness of CHP implementation and make recommendations for upgrades to the program. Serve as interface with Cal-OSHA regarding CHP issues.

e. Laboratory Safety Committee
The committee is co-Chaired by the Vice Chancellor of Research and the Associate Vice-Chancellor of Administrative Services. The LSC functions as a venue for EH&S/CHOs to receive

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input from the campus laboratory community on the content and effectiveness of the CHP and other lab safety issues. Other research-related committees include: Biosafety; Radiation Safety; Institutional Animal Care and Use; Diving Control Board.

f. Departments and Organized Research Units
   • Under the campus *Injury and Illness Prevention Program* (Cal-OSHA requirement), and the associated [UCSB written program], the **department/unit Head or Chair is identified as the individual with the authority and responsibility to implement the IIPP**. The IIPP is the umbrella OSHA regulation, under which all worker safety programs exist.
   
   • To assist the Chair/Unit Head, each department has a **Department Safety Representative (DSR)** who coordinates health and safety program elements in the department and serves as a liaison with EH&S.
   
   • General oversight of department operations and communicating with supervisors and personnel any relevant safety issues, problem solving, and preplanning for emergencies.
   
   • Per UC policy, depts. are responsible for ensuring that all new lab workers attend a *Fundamentals of Laboratory Safety* orientation before lab access is granted - Sec. III.C.1.
   
   • Ensure that all operations under departmental control develop and implement lab-specific CHPs. While individual lab supervisors have the primary responsibility, department administrations need to coordinate and support these efforts.

h. Laboratory Workers (non-supervisors)
   General responsibilities are below - a more [complete list] is online.
   
   • Follow established work policies and procedures, including the UC Personal Protective Equipment policy; Laboratory Safety Training policy, CHP and authorizations from campus safety committees.
   
   • Attend and actively participate in appropriate safety training.
   
   • Notify the laboratory supervisor or EH&S of any unsafe or potentially unsafe condition.

Workers have rights under the law - See also the *UCSB Injury & Illness Prevention Program*
   • to be informed of the hazards in their workplace
   • to be properly trained on safe work practices
   • to be provided appropriate personal protective equipment needed for the job at no cost
   • to file a complaint with Cal-OSHA if they feel they are being exposed to unsafe conditions and no reprisals can be taken against them.

**Facilities Management** - see Section III.C.5
C. PROGRAM ELEMENTS OF THE UCSB CHEMICAL HYGIENE PLAN

1. Employee Information and Training

One of the major provisions of the Laboratory Standard and the OSHA Injury and Illness Prevention Program is a requirement for employee information and training. The employer must convey information to the employee regarding occupational hazards identified in the workplace. In general, training is required for:

- All new employees and employees given new job assignments involving exposure situations for which training has not previously been received
- Whenever the employer is made aware of a new or previously unrecognized hazard for which training has not previously been received

UC Laboratory Safety Training Policy

In October 2014, UC adopted a new policy entitled UC Laboratory Safety Training Policy to reinforce and support OSHA requirements and increase safety. Lab supervisors have the primary responsibilities for implementing the policy provisions, which include:

1. Ensure all “lab workers” complete an EH&S “Fundamentals of Laboratory Safety” training in order to be given access to their labs. Class enrollment directions and descriptions are in Sec. II. The training covers most of the issues mandated in the Lab Standard (see below).

2. However, the fundamentals course does not address lab-specific training issues and it is incumbent on the lab supervisor to do so. This is done via a Training Needs Assessment (pdf; Word) to be performed for each lab worker as mandated in the UC policy. See pg. II-21.

<table>
<thead>
<tr>
<th>Safety Training Required by the Laboratory Safety Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Worker rights &amp; responsibilities per Laboratory Standard and the Injury &amp; Illness Prevention Program</td>
</tr>
<tr>
<td>*Contents of the generic portions (Sec. II) of the UCSB Chemical Hygiene Plan</td>
</tr>
<tr>
<td>*Concept of Permissible Exposure Limits for OSHA-regulated substances and access to list</td>
</tr>
<tr>
<td>*Hazardous materials labeling, storage, and signage requirements</td>
</tr>
<tr>
<td>*Relevance and access to SDSs and other informational references and resources pertinent to the lab</td>
</tr>
<tr>
<td>*Spill response, waste disposal and emergency procedures</td>
</tr>
</tbody>
</table>

-Contents of the lab-specific Chemical Hygiene Plan, including any SOPs  [Lab supervisor responsibility]

-The hazards of hazmat including signs and symptoms of overexposure, including Particularly Hazardous Substances - Sec. III.C.3. As appropriate, training can address entire classes of materials rather than individual substances.  [Major classes of chemical hazards are covered by EH&S*, but not lab-specific hazards. These should be addressed in a lab’s SOPs - CHP Sec. I]

-Appropriate use of control measures including engineering controls, personal protective equipment, and work practices.  [Generic control measures covered by EH&S*]
2. Standard Operating Procedures
The OSHA Laboratory Safety Standard states that a laboratory’s CHP include: “Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals”, defined as:

- A health hazard, or simple asphyxiant
- A health hazard is a chemical that is classified as posing one of the following hazardous effects: Acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); aspiration hazard.

It is incumbent on lab supervisors to develop lab-specific SOPs for operations which involve the use of a “hazardous chemical”. Specific guidance on how to prepare SOPs are given in Section I. In short, EH&S has developed SOP templates for the common classes of hazardous chemicals (e.g., oxidizers, corrosives), or in some cases specific chemicals (e.g., formaldehyde) that labs only need to customize with some local information. In general:

- SOPs should contain information about hazards and how these hazards will be mitigated
- Special focus should be on SOPs for “Particularly Hazardous Substances” (PHS) – human carcinogens and reproductive toxins, acutely toxic materials. (see C.6). In many cases chemicals with similar hazards and safety controls can be grouped together into a single SOP (“control banding”).
- SOPs should be written by lab personnel who are most knowledgeable of the experimental process and approved by the supervisor
- SOPs within a CHP must be reviewed by lab workers and be kept where workers can easily access them

3. Particularly Hazardous Substances (PHS)
The Laboratory Standard states that: “The Chemical Hygiene Plan shall include... provisions for additional employee protection for work with hazardous substances, including “select carcinogens,” reproductive toxins and substances which have a high degree of acute toxicity

SELECT CARCINOGENS— Includes carcinogens as listed by the following organizations: OSHA; the National Toxicology Program; the International Agency for Research on Cancer. See also Sec. II.

REPRODUCTIVE TOXINS— A chemical which affects human reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

HIGH ACUTE TOXICITY SUBSTANCES— Substances such as hydrogen cyanide or hydrogen sulfide which may be fatal or cause damage to target organs as a result of a single exposure or exposures of short duration.

It is the responsibility of individual lab supervisors to institute SOPs for using a specific Particularly Hazardous Substance in their laboratories. See Section I for template forms and instructions.

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The PHS section of the Lab Standard goes on to say: “Specific consideration should be given to the following provisions which shall be incorporated where appropriate:

1. “Establishment of a designated area”
2. “Use of containment devices such as fume hoods or glove boxes”
3. “Procedures for safe removal of contaminated waste”
4. “Decontamination procedures”

Again, directions/templates for addressing these issues is provided in section 1 of this CHP.

4. Criteria for Determination and Implementation of Control Measures

The Laboratory Standard states that the CHP “.... shall include criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals .....” Hazard controls are generally classified into three broad groups: engineering controls, administrative procedures and personal protective equipment. Guidance on control measures are delineated here.

A. General

- Lab supervisors shall determine and implement appropriate control measures and preferably incorporate them into their lab’s individual SOPs
- Environmental Health & Safety shall be responsible for assisting the above in determining these control measures upon request. EH&S may do periodic evaluations of control measures on campus as deemed necessary and notify lab supervisors of their results and recommendations.

B. Engineering Controls—Criteria for Implementation (see Sec. II-15)

C. Administrative Controls—Criteria for Implementation

The variety of possible administrative controls to reduce hazard levels in laboratories is large, e.g., training, signage, labeling, SOPs, etc. The controls instituted by a given laboratory shall be determined by the lab supervisor in consultation with EH&S, as needed. In general, measures shall be implemented:

- As indicated in Standard Operating Procedures
- As mandated by health and safety regulations, or as called for by accepted good practice

D. Personal Protective Equipment—Criteria for Implementation

Appropriate personal protective equipment (PPE) practices are stipulated in the UC policy titled: Personal Protective Equipment (March 2014). The key provisions of the policy are summarized in Sec. II, pgs. 6 to 10 of this manual.
5. Maintenance of Engineering Controls, Personal Protective Equipment and Emergency Equipment

Per the Laboratory Standard: “.....a requirement that fume hoods comply with section 5154.1 (Title 8, CCR), and that all protective equipment shall function properly and that specific measures shall be taken to ensure proper and adequate performance of such equipment.....”

General Responsibilities:

**FACILITIES MANAGEMENT (FM):** Responsible for routine maintenance, replacement and installation of University-owned building emergency systems and environmental controls. Must inform affected departments and/or individuals in a timely way when building systems are, or will be, non-functional.

**ENVIRONMENTAL HEALTH & SAFETY:** Responsible for evaluating effectiveness of engineering control measures and emergency equipment used. Will make recommendations to FM and users on implementation of appropriate equipment and control measures as needed.

**LAB SUPERVISOR/LAB PERSONNEL:** Responsible for monitoring status and effectiveness of equipment and control measures. Responsible for reporting to appropriate campus entity if equipment is not functional. Responsible for maintaining and testing equipment they own.

Specific Responsibilities:

**FUME HOODS/GAS CABINETS (per CCR, Title 8, 5154.1)**

- **Maintenance:** Facilities Management
- **Annual certification:** EH&S

**BIOSAFETY CABINETS (per CCR, Title 8, 5154.2)**

- **Maintenance:** Owner (generally lab supervisors)
- **Annual certification:** Generally, owner covers cost of outside vendor certification – generally TSS, Inc. via UC contract. Biosafety Committee typically requires cabinet use as part of their authorization

**LAB-OWNED or SPECIALIZED LOCAL EXHAUST VENTILATION (e.g., laminar flow hoods)**

- **Maintenance & testing:** Owner responsibility. Given the specialized nature of these, FM does not have the expertise to maintain these.
- **Certification testing:** Owner responsibility. Given the specialized nature of these, FM nor EH&S have the capability to test these and should be performed by an outside testing company like TSS, Inc. under UC contract.

**EMERGENCY SHOWERS AND EYEWASHES (per CCR, Title 8, 5162)**

- **Administration:** EH&S has sole responsibility for approval, fit-testing and issuance. Supervisors are responsible for identifying and directing individuals to EH&S who may require respirators.
6. Hazard Identification

Policies and regulations on hazard identification with respect to labeling and SDS are:

- Labels on incoming containers of hazardous chemicals are not to be removed or defaced.
- The primary campus access to Safety Data Sheets is through the internet - see Sec. II-13. Individual labs are encouraged to maintain their own hardcopy files as well.
- For chemical substances developed in University laboratories, the provisions for hazard determination, training and labeling shall be those stated in the Laboratory Standard.

7. Prior Approval

Another provision of the Laboratory Standard is for incorporating policies into the CHP on: “The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer’s designee before implementation.”

Given the diversity of chemical work done in campus laboratories, it is impossible to specify the operations which would require prior approval. It is therefore the responsibility of individual lab supervisors to establish these criteria, if any, for their operations. Establishment of prior approval criteria is solely the prerogative of the lab supervisor. These criteria should be incorporated into lab’s SOPs. There is a field in the UCSB SOP templates for including.
8. Medical Consultation and Examination

The Laboratory Standard states that: “The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances”:

- When an employee develops signs or symptoms associated with a hazardous chemical to which that employee may have been exposed
- Where exposure monitoring reveals an exposure level routinely above the action level or PEL for an OSHA-regulated substance
- Whenever an event takes place in the work area such as a spill, leak, or explosion resulting in the likelihood of a hazardous exposure

The University has established the following procedures, when it is known or suspected that a worker has been exposed to a hazardous chemical(s) or is otherwise injured on campus.

- All employees suffering from chemical exposure or other work-related injury incurred at UCSB shall be evaluated/examined at University expense. Students are covered by their required medical insurance.
- If the injured/exposed person is safe to transport, escort them to either Student Health Services (undergraduate students), Goleta Valley Community Hospital, or their primary physician for evaluation. Contact EH&S at x3194, or x4440 immediately to initiate medical coverage procedures.
- In some cases a work-related chemical exposure may be suspected but not certain. For example, some low-level but chronic exposures may be difficult to identify or relate to specific symptoms. In these instances, contact the Chemical Hygiene Officer at x4899 to arrange a review of the suspected exposure.
- The Laboratory Standard includes specific provisions regarding the employer’s exchange of information with the examining physician. The provisions of the Standard will be followed as stipulated therein.

9. Criteria for Establishing Exposure Monitoring

The legal limits for occupational exposure to ~500 chemicals which are toxic by inhalation, or skin contact, are codified by OSHA in so-called Permissible Exposure Limit (PEL) values.

Exposure monitoring for any substance regulated by OSHA will be done if there is reason to believe that exposure levels exceed the action level, or Permissible Exposure Limit. The tasks of determining if monitoring is required and performing the monitoring shall be the sole responsibility of EH&S. For “regulated carcinogens” (See Sec. II-11) EH&S does periodic reviews of usage practices and monitoring to establish if there is reason to suspect there are exposures.