Lab-Specific Chemical Hygiene Plan (CHP)

General Information & Standard Operating Procedures (SOPs)

for the Safinya Laboratories

(MRL rooms 1012, 1012B, 1016, 1024, 1032)

Chemical Hygiene Officer (CHO):
David Vandenberg (David.Vandenberg@ehs.ucsb.edu)
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Date of last revision to SOP: Aug. 2014 – Kai Ewert
PI approval of SOP:
Scope of SOP
Compound information
Approval Required
General precautions
Personal Protective Equipment
Engineering/Ventilation Controls
Handling, Storage, Cleanup, First Aid, and Disposal Requirements
Additional Information

LCSS for DICHLOROMETHANE

Documentation of Training

SOP: Use of Formaldehyde and Formalin (aqueous formaldehyde solution)

Date of last revision to SOP: Aug. 2014 – Kai Ewert
PI approval of SOP:
Scope of SOP
Compound information
Approval Required
General precautions
Personal Protective Equipment
Engineering/Ventilation Controls
Handling, Storage, Cleanup, First Aid, and Disposal Requirements
Additional Information

LCSS for FORMALDEHYDE

Documentation of Training

SOP: Use of Ethidium Bromide

Date of last revision to SOP: Aug. 2014 – Kai Ewert
PI approval of SOP:
Scope of SOP
Compound information
Approval and Training Required
Chemical Hazard
General precautions
Personal Protective Equipment
Engineering/Ventilation Controls
Special Chemical Handling, Storage, Cleanup and Disposal Requirements
Additional Information

LCSS for ETHIDIUM BROMIDE

Documentation of Training

SOP: Use of “Particularly Hazardous Substances”

Date of last revision to SOP: Aug. 2014 (Kai Ewert)
PI approval of SOP:
Definitions / Compound Lists
Approval Required
General precautions
Personal Protective Equipment
Engineering/Ventilation Controls
Special Chemical Handling, Storage, Cleanup or Disposal Requirements

LCSS for PARTICULARLY HAZARDOUS SUBSTANCES

Documentation of Training
SOP Template: High Hazard Lab Operations

Date of last revision to SOP: ____________________________
Scope of SOP: ______________________________________
PI approval of SOP: __________________________________
Approval Required: __________________________________
Hazardous Chemicals: ________________________________
Personal Protective Equipment: __________________________
Engineering/Ventilation Controls: _______________________
Any Special Chemical Handling, Storage, Cleanup or Disposal Requirements: ____________________________
Other: _____________________________________________

Documentation of Training: ____________________________

SOP: Chemical Storage

Date of last revision to SOP: Aug. 2014 – Kai Ewert
PI approval of SOP: __________________________________
Basic Instructions: __________________________________
Proper Segregation of Incompatible Chemicals: ___________
Compressed Gas: _____________________________________
Additional Information: ________________________________

SOP: Preparing For a New Project

Date of last revision to SOP: Aug. 2014 (Kai Ewert)
PI approval of SOP: __________________________________

SOP: Chemical Spill Cleanup

Date of last revision to SOP: Aug. 2014 (Kai Ewert)
PI approval of SOP: __________________________________
First things first: _____________________________________
• Call 9-911 if there is a fire, personal injury, or danger to life or property.
Chemical Spill Cleanup Procedure: ______________________

SOP: Evacuated Glass Apparatus

Date of last revision to SOP: Aug. 2014 (Kai Ewert)
PI approval of SOP: __________________________________
Scope of SOP: ______________________________________
Hazards: __________________________________________
Required personal protective equipment: ________________
Preventative measures: _______________________________

Documentation of Training: ____________________________

SOP: Enclosed Glass with Cryogenic Cooling

Date of last revision to SOP: Aug. 2014 (Kai Ewert)
PI approval of SOP: __________________________________
Scope of SOP: ______________________________________
Hazards: __________________________________________
Required personal protective equipment: ________________
Other safety precautions: ______________________________
Additional Information: ______________________________

Documentation of Training: ____________________________

Appendix A: EH&S laboratory safety fact sheets
Appendix B: Chemical Resistance of Common Lab Gloves
Appendix C: MRL Emergency Operations Plan
Appendix D: MRL Combined Injury & Illness Prevention Plan and Hazard Communication Plan
Appendix E: Laboratory Self-Inspection Checklist
Appendix F: LHAT assessments for the Safinya Labs
Preface

All labs using chemicals are required by Cal-OSHA to have a written safety plan (Chemical Hygiene Plan, CHP) in place for chemical workers. It is the responsibility of the lab supervisor/PI to ensure that a complete Chemical Hygiene Plan is developed, implemented and shared with all affected workers. This CHP contains important, lab-specific safety information such as standard operating procedures (SOP) for common procedures done in the lab. The idea behind having these SOPs written out is to minimize exposure to hazardous chemicals for the people performing the procedures.

These pages should be filed under the “Chemical Hygiene Plan” tab of the lab’s CHP binder. If you find pages or information missing from this binder, you do not understand parts of its content, or you need other help with chemical safety questions, contact

Kai Ewert  MRL room 2222  ewert@mrl.ucsb.edu
or
Youli Li  MRL room 2202  x8104  youli@mrl.ucsb.edu
or
UCSB EH&S  x4899  http://ehs.ucsb.edu
Introduction

This is section I (the lab-specific section) of the Chemical Hygiene Plan (CHP) for the Safinya Lab. It consists of three main parts. The first is general information which applies to everyone working in the lab. The next part contains a number of “Standard Operating Procedures” (SOPs) for processes in the lab which involve safety hazards. These are intended to give the user information about the potential hazards of the process and how to avoid these. The last part is an appendix containing a number of relevant documents, most prepared by UCSB EH&S.

The origin of the regulations requiring a CHP and SOPs assume an industrial production lab with fixed procedures. In academic research laboratories, however, procedures, materials, and hazards are constantly changing. Therefore, this document can never fully cover all safety issues in our lab. Instead, it strives to lay the foundation for safety in the laboratory by providing a framework upon which each lab researcher can build as well as a collection of safe best practices for commonly used procedures.

Due to the changing nature of work in an academic laboratory, it is the responsibility of each and every person working in this lab to do the inquiry, the literature research, and the thought required to understand and mitigate the hazards of their experimental work before they proceed with it. A good starting point is to get educated about the chemical hazards of the materials to be used (see the resources provided in this document). In addition, lab members should consult other people who have done similar work and feel free to contact Kai Ewert and Youli Li with questions or concerns. This CHP also includes an SOP for “Preparing For A New Project”, which aims to give guidelines on this important subject.

Everyone working in the Safinya Laboratory needs to read this Chemical Hygiene Plan once and review it annually. Please document that you have fulfilled this requirement by signing a log sheet in the office of Kai Ewert, MRL room 2222.

Kai Ewert, March 2013
Twelve Commandments for Lab Safety
(in place of a summary)

You will find more detailed information on all of these items on the following pages.

1. **You must not work** in the lab before completing your safety trainings.

2. Wear your **safety glasses** in the lab. Wear **closed-toe shoes**. Wear **lab coat, gloves, etc. as required** (see reverse page).

3. **No food, drink, smoking** in the lab.

4. **Know** what you are doing and be aware of the **hazards** of your (and your neighbors!) work (chemicals, tools, processes): ask other lab members or consult relevant literature, e.g. the CHP, SDSs, etc.

5. **Do not pour waste down the drain.** Use the appropriate collection bottle. All **sharps** (glass, needles, blades) need to go into **designated containers**.

6. **Always keep fume hood sashes as low as possible.**

7. **Secure gas cylinders** to the wall with metal chains.

8. **Do not use damaged electrical cords.** Keep power strips off the floor. Do not chain extension cords / power strips.

9. **Do not block lab aisles** with chairs, stools, or equipment.

10. **Store** only **compatible chemicals** close to each other. Ask if you are not sure. Do not store heavy items overhead.

11. Do not touch doorknobs, phones, computers, etc. with gloved hands.

12. **Label** your samples with your name and the appropriate chemical names.
General Laboratory Information

Laboratory Supervisor (PI)

Cyrus R. Safinya (MRL room 2204, x8635, safinya@mrl.ucsb.edu)

Laboratory Locations (Building /Rooms)

MRL (building 615), rooms 1012, 1012B, 1016, 1024, 1032 (floor plan below)

Laboratory Safety Coordinators (Safety Czars)

Chemical Safety and MRL labs:

Kai Ewert (office: MRL room 2222, ewert@mrl.ucsb.edu)

X-ray Safety (and CNSI labs):

Youli Li (office: MRL room 2202, x8104, youli@mrl.ucsb.edu)
Department Information (MRL)

Department Safety Representative / Hazard Communication Coordinator

Amanda Strom (room 2066F; x7925, amanda@mrl.ucsb.edu)

For all safety matters that go beyond our lab or that can not be settled by talking to Kai or Youli, you may want to contact Amanda Strom, the Safety Representative for the MRL. He is also in charge of the overall maintenance of the MRL and several of the instruments housed here. Thus, he’s a good person to know.

Location of the Department Safety Bulletin Board

MRL room 2042 (2nd floor kitchen)

The MRL Safety Corner bulletin board is a place where safety and other important information concerning the whole MRL is posted. The next time you are using the fridge, getting water, or waiting for your food to warm up in the microwave, check it out.

Location of MRL Building Emergency Assembly Point (EAP)

The EAP is diagonally across the road from the main entrance of the MRL (in between Physics and Eng II) on the Isla Vista Side of the Eng II Building (marked by a star on the adjacent map)

Proceed to the EAP in the event of any evacuation or fire alarm, be it real, a drill, or a malfunction of the alarm system. Remain there until everyone is accounted for. Do not reenter the building until instructed to do so by authorized personnel.
Emergency Information

Emergency procedures

Campus EH&S has compiled helpful essential information on how to respond to a variety of emergencies and hazardous situations in a flip-chart type manual. A copy of this manual is posted next to each lab door. Contact Kai or Youli if you find one missing. More information on specific scenarios (fires, chemical spills, and earthquakes) is also provided below.

Remember that you need to dial 9-911 from campus phones for emergency calls (and 805 893 3446 from cell phones'). As soon as it is safe for you to do so, also notify Kai (cell: 805 252 4318) or Youli (x8104; 805 683 6754 after hours). If poisoning is suspected, contact Poison Control Center at 800 222 1222.

For emergency contact information regarding incidents in the lab, see the placards on the lab doors. If in doubt who to call, contact Kai, Youli (x8104) or Amanda Strom (x8125).

Evacuation procedures

If evacuation is advised (most emergencies with the notable exception of earthquakes), leave the lab as quickly as possible through the closest door that is not obstructed. Then proceed to the East (main, Isla Vista side) exit of the MRL and the Emergency Assembly Point (EAP) on the Isla Vista side of Eng. II (see map above). If the East exit is blocked, use the West exit (ocean/KITP side). Emergency exit plans for all three floors of the MRL are posted on the Safety Corner bulletin board (see above). The MRL EOP (on the web, see below) also has this information.

In the event of a fire, do not leave doors and windows open. If possible, operate the emergency power shutoffs before you leave the lab. If there is time to do so safely, take valuable personal property.

First-aid kit

A basic First Aid Kit is available next to the door in room 1012, on your left as you enter the lab – behind the station with the SDS/MSDS. The kit is maintained by Youli Li (x8104, youli@mrl.ucsb.edu).

Spill cleanup materials

A spill cleanup kit is located in the cabinet under the sink in room 1012 that is adjacent to the fume hood. EH&S should be contacted for any major or particularly hazardous cleanups (e.g. mercury spills from a thermometer) at x3194. This phone number is available 24 hours a day. After hours, emergency personnel can be paged through this

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1 simply dialing 911 from a cell phone will not contact UCSB dispatch, but rather the Ventura dispatch, which may result in delays
number. An SOP (Standard Operating Procedure) for handling chemical spills is provided in this CHP (page 99), and the EH&S flip-chart manuals (posted next to every lab and office door) also have information on what to do in the event of a chemical spill.

Laboratory monitors and alarms

The only lab monitors are low air flow monitors on the fume hoods. These are maintained by Campus Facility Management (x8300). They will sound an alarm (beeping) if airflow is at an unsafely low level. Do not override these alarms.

Fires

Below you will find information for the event of a fire in the lab or the MRL building.

Fire alarm and Evacuation Guidelines

The fire alarm in the MRL building consists of flashing strobe lights (these lights are mounted along the main hallways and also outside of the building) and an audible alarm. The audible alarm is a siren and a spoken message, notifying occupants of a fire and asking them to leave the building. If the fire alarm goes off, you must leave the building, no matter whether it is an actual alarm or a preannounced test of the system. Do not use the elevators, leave the building through the nearest available exit and find your way to the Emergency Assembly Point at the SW (Isla Vista) corner of Engineering II (see above).

Reporting a fire

For reporting a fire, a fire alarm pull station is located on the wall of the main hallway, near the main exit of the MRL (across from the elevator). This will be pointed out to you as part of your lab-specific safety training. Per SB County Fire and UCSB campus policy, all fires must be reported to 9-911 immediately – even if the fire is out. This is particularly true if there was use of an extinguisher (which always must be replaced, even if only used partially!), any injury, or property damage.

Fire Extinguishers

There are two types of fire extinguishers in the lab. The common standard are fire extinguishers that use powder. Each of the main rooms (1012, 1024, and 1032), have one of these, located next to the doors that lead to the hallway. These extinguishers can be used for any fire, including electrical fires. However, they make a gigantic mess and the fine powder that they dispense is not only hard to clean, it can also damage and destroy electrical equipment. Therefore, we also have an alternative, which is a CO₂ extinguisher. This is located next to the door in room 1012 (Safinya XRD lab). This is the type of extinguisher that you used in your lab safety training. Unless you are dealing with fire on electrical equipment, this is the preferred extinguisher to use.
If a fire extinguisher has been used, no matter for how brief, it must be replaced. Contact Kai Ewert or Amanda Strom to do this.

In the Event of an Injury

Follow the procedures outlined below, which can also be found on the blue emergency flip-charts located in every MRL office and lab (next to the door), under the heading "MEDICAL EMERGENCY".

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, where they may not be seen or treated for a long time if they don’t arrive in an ambulance. There is no charge for having the paramedics come out and evaluate the victim. (If the victim needs to be transported to Student Health Services or a hospital emergency room there is a charge.) If poisoning is suspected, contact Poison Control Center at 800 222 1222. If an employee is hospitalized for more than 24 hours (other than for observation), or has an injury that results in partial or full loss of limb (amputation), or loss of life, contact EH&S at x3194 (24 hour phone line) immediately. The campus must report these injuries to OSHA within 8 hours of the event.

Other Injuries

It is important that all work-related injuries be reported immediately. Have your supervisor call the Work Injury Reporting Hotline at 877 682 7778 to report injuries and obtain an authorization for initial medical treatment. For injuries not threatening to life or limb, undergraduates and graduate students may be treated at Student Health Services (SHS), phone number x3371. A map showing the location of Student Health Services is at:

http://studenthealth.sa.ucsb.edu/Undergraduate/mapofucsb.aspx
Health & Safety References

NOTE: Safety Data Sheets (SDS)  
(formerly known as Material Safety Data Sheets/MSDS):

Per OSHA regulations, all lab chemical users must know: a) what an SDS is; b) SDS relevance to their health and safety; and c) how to readily access them. These issues are all covered in the EH&S lab safety training. In brief, an SDS is a compilation of hazard/safety information for a given chemical or mixture, provided by the manufacturer. SDS often are the most readily accessed source of information about potential hazards of the chemicals you are working with. See below for sources of SDS and further information.

Written Safety Resources & References

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<td>Lab Chemical Hygiene Plan aka the Black Binder</td>
<td>room 1012 (near door)</td>
</tr>
<tr>
<td>Yellow binder with Safety Data Sheets</td>
<td>room 1012 (near door)</td>
</tr>
<tr>
<td>(This is where SDS for routinely used chemicals should be kept)</td>
<td></td>
</tr>
<tr>
<td>Merck Index</td>
<td>room 1012 (near door)</td>
</tr>
<tr>
<td>Biosafety in Microbiological and Biomedical Laboratories</td>
<td>room 1012 (near door)</td>
</tr>
<tr>
<td>Prudent Practices for Handling Hazardous Chemicals in Laboratories</td>
<td>room 1012 (near door)</td>
</tr>
<tr>
<td>Prudent Practices for Disposal of Chemicals from Laboratories</td>
<td>room 1012 (near door)</td>
</tr>
<tr>
<td>Dangerous Properties of Industrial Materials, 8th Ed.</td>
<td>office Amanda Strom (2066F)</td>
</tr>
<tr>
<td>Health And Safety Binder (aka The Green Binder)</td>
<td>office Amanda Strom (2066F)</td>
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<tr>
<td></td>
<td>and online (see below)</td>
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Electronic Safety Resources & References

Reference and Location

EH&S page with electronic SDS resources
http://ehs.ucsb.edu/units/labsfty/labrsc/chemistry/lschemmsdsacc.htm

MRL Safety webpage
http://www.mrl.ucsb.edu/mrl-safety-information

UCSB Environmental Health and Safety (EH&S) main website
http://ehs.ucsb.edu

Note: UCSB EH&S has posted vast amounts of useful safety information on their web page, but it is not always easy to locate. Some subjects covered (use the Search function on the site to find it) are listed below (see also the following references)

- Introduction to Campus Procedures and Resources
- Personal Protective Equipment in UCSB Storerooms
- Eyewear Policy and Selection
- Selecting the Proper Gloves
- Chemical Spill Cleanup Procedures
- Hazardous Waste Disposal Procedures
- Fire Fighting and Extinguishers
- EH&S Lab Safety Class Descriptions
- Laboratory Self-Inspection Checklist (see Appendix E)

Health And Safety Binder (aka The Green Binder)
http://ehs.ucsb.edu/units/iipp/iipprsc/greenbook.htm

Lab Safety Info at UCSB EH&S website
http://www.ehs.ucsb.edu/units/labsfty/labsafety.html

Emergency Assistance Info
http://ehs.ucsb.edu/units/emplan/eprsc/emergphone.htm
Lab Safety Fact Sheets (one page summaries of important safety issues by UCSB EH&S and links to similar resources on other campuses)

http://ehs.ucsb.edu/units/labsfty/labrcf/reports/factsheets/lsfacsheets.htm

Note: These are a good first stop for safety information and are available on the following subjects. Appendix A contains the fact sheets marked with an asterisk (*)

Chemicals:
- Acrylamide*
- Arsenic
- Azides, Handling Organic*
- Benzene*
- Cadmium
- Chlorinated Solvents*
- Corrosives*
- Dichloromethane (also known as methylene chloride)*
- Ethidium Bromide Safety*
- Formaldehyde*
- Hydrofluoric Acid
- Perchloric Acid
- Peroxides and Distillations
- Phenol*
- Picric Acid
- Pyrophoric Organolithium Reagents
- Water Reactive and Pyrophoric Materials

Chemical Safety:
- Carcinogen Control*
- Chemical Storage*
- Cryogens*
- Housekeeping Guide for labs*
- Lab Coats*
- Nanomaterials Safe Handling
- Power Failures Guide*
- Quenching Solvent Drying-Still Bottoms
- Seismic Hazard Reduction*
- Sharps Disposal*
- TA Guide
- Time-Sensitive Chemicals*

Lab Equipment:
- Autoclaves*
- Centrifuge*
- Compressed Gas Cylinders*
• Electrophoresis Equipment*
• Environmental Rooms
• Fume Hood Usage Guidelines*
• Refrigerator & Freezers in Lab*

Hazardous Waste:
• Biological Waste Disposal*
• Chemical Waste Disposal*

Hazardous Waste Refresher (online course)
   http://ehs.ucsb.edu/4DAction/WebCourseDescription/100696/1

Accident Descriptions on the EH&S website (every accident has a lesson to teach)
   http://www.ehs.ucsb.edu/units/labsfty/labsc/Incidents.htm

   http://www.nap.edu/catalog.php?record_id=12654

Safety in Academic Chemistry Laboratories, American Chemical Society, 7th ed., 2003. This work comes in two volumes, one for students and one for faculty/administrators. Look for it online or request a PDF from Kai
Important Phone Numbers and Contact List

Emergency phone numbers

Call

<table>
<thead>
<tr>
<th>Phone Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>911</td>
<td>from payphones, residence hall phones</td>
</tr>
<tr>
<td>9 911</td>
<td>from campus phones</td>
</tr>
<tr>
<td>805 893 3446</td>
<td>from cell phones (when on campus)</td>
</tr>
</tbody>
</table>

(simply calling 911 from a cell phone will not contact UCSB dispatch, but rather the Ventura dispatch, possibly causing delays)

Call 800 222 1222 (Poison Control Center) if poisoning is suspected

- Also consult the flip-chart manual posted next to every lab and office door

Other important phone numbers

Amanda Strom       x7925
Youli Li           x8104
Kai Ewert          805 252 4318 (cell)
Joni Schwartz      x8519
Facilities management x8300
For fire extinguisher recharge x3305
Student Health Services x3371
EH&S 24-hour hotline x3194

Campus emergency information (55c / call or min) (900) 200 8272
Highway information (Caltrans) (800) 427 7623
UCSB Emergency Operations Center campus status x8690

The following two pages reproduce the “EH&S Guide to services phone list”, available at
### UCSB Lab-specific Chemical Hygiene Plan

The office of Environmental Health & Safety (EH&S) is committed to promoting a safe and healthful environment for research, instruction and the campus community. Through education, auditing and monitoring, technical consultation, and the provision of direct services, EH&S assists the campus in meeting its obligations for compliance with State and Federal health, safety and environmental regulations.

#### Environmental Health Guide to Services

<table>
<thead>
<tr>
<th>Service</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asbestos/Lead (D&amp;CS)</td>
<td>x7984</td>
</tr>
<tr>
<td>Biological Safety</td>
<td>x8894</td>
</tr>
<tr>
<td>Diving Safety</td>
<td>x4559</td>
</tr>
<tr>
<td>Emergency Management</td>
<td>x3154</td>
</tr>
<tr>
<td>Environmental Health</td>
<td>x8533</td>
</tr>
<tr>
<td>Ergonomics</td>
<td>x3283</td>
</tr>
<tr>
<td>Event Management</td>
<td>x7751</td>
</tr>
<tr>
<td>Fire Protection</td>
<td>x4407</td>
</tr>
<tr>
<td>General Safety/Injury Prevention</td>
<td>2661x2306</td>
</tr>
</tbody>
</table>

**Technical Assistance Phone:** 893-3194  
**General Information:** 893-7534  
**Fax:** 893-8659

---

**Asbestos/Lead (D&CS)**

Monitors building projects to ensure against releases of asbestos fibers or lead. Provides annual notification to employees of known asbestos in campus buildings. Teaches protective measures to employees who have potential for occupational exposure.

**Biological Safety**

Facilitates compliance of biobehavioral research to regulations and NIH guidelines. Reviews protocols involving potentially infectious organisms, toxins and certain recombinant DNA strategies to ensure the safety of people and the environment from any adverse effects.

**Diving Safety**

Oversees all SCUBA programs and provides the training, dive planning and logistical support required for researchers to conduct their work underwater.

**Emergency Management**

Implements strategies and procedures to prepare the University for potential emergencies. Educates the campus community on emergency preparedness, response and recovery topics.

**Environmental Health**

Oversees the community health and sanitation programs, including food operations, water quality, pest management, and pool sanitation.

**Ergonomics**

The science of designing user interaction with equipment and workplaces to fit the user. It relates to the reduction of injuries in all types of jobs. Services include job task evaluation, body mechanics/back care training, evaluations/recommendation of product/tools, and workplace/workflow design to maximize efficiency and comfort for employees.

**Event Management**

Monitors events and assists groups in meeting fire and life safety requirements. Provides emergency awareness training and develops emergency response plans related to fire and emergency evacuation.

**Fire Protection**

Assists employees in identifying and eliminating workplace fire hazards. Approves building and renovation plans to ensure compliance with fire and life safety codes. Provides instruction on fire alarm systems and fire protection equipment. Provides training in fire and life safety and offers classes in fire extinguisher use.

**General Safety/Injury Prevention**

Manages programs on accident investigation, shop safety, fall protection, lock-out/tag-out, driver safety, vehicle and equipment safety, CPR/First Aid, injury prevention efforts as well as general campus safety hazards. Provides consultation, training and certification.
## Environmental Health & Safety Guide to Services

### Hazardous Chemical Management
- Maintains lab door placard program to provide information to emergency responders.
- Monitors campus use of large quantity chemicals, toxic gases and other hazardous materials for compliance with applicable local and federal regulations.

### Hazardous Waste Disposal
- Manages disposal of all chemical waste generated on campus. Program includes waste pickups, pollution prevention, regulatory compliance, and maintaining emergency response capabilities.

### Industrial Hygiene/Occ Health
- Provides information, consultation and training on industrial hygiene/occupational health subjects such as respiratory protection, hearing conservation, heat illness, confined space and hazard communication. Conducts IAQ surveys, exposure assessments and recommends control measures.

### Injury & Illness Prevention
- Coordinates development of departmental Injury and Illness Prevention Programs with Department Safety Representatives (DSRs).

### Lab Safety
- Provides training, information and inspections to foster safe and legal lab practices to protect workers against chemical and physical hazards.
- Reviews all new lab construction and renovation plans. Assists labs in developing their OSHA Chemical Hygiene Plans. Investigates lab accidents and coordinates hazardous materials emergency response activities.

### Laser Safety
- Provides training, safety information and laser safety audits to assist compliance with applicable policies and regulations.

### Radiation Safety
- Provides training, laboratory inspections, radiation exposure monitoring for both radioactive material and X-ray producing machine users.
- Manages the campus radioactive waste disposal program, including waste pickup, storage and disposal.

### Risk Management
- Protects the campus from the risk of unanticipated loss, manages UC's insurance programs, manages the campus response to lawsuits and claims, analyzes risks involved in campus activities and use of facilities, resolves contract insurance and indemnification issues.

### Stormwater Management
- The purpose of stormwater management is to protect and restore the physical, chemical, and biological integrity of our nation's waterways by controlling and limiting discharges of pollutants to these waterways.

### Training
- Assists supervisors in meeting legal requirements to train each employee in health and safety practices and occupational hazards by providing classes, videos, publications, and manuals.

### Workers' Compensation
- Workers' Compensation is a state-mandated insurance plan designed to be a "no-fault" system. Provides benefits and assistance to all employees who are injured or develop a job-related illness as a result of their employment.

### Related Phone Numbers

<table>
<thead>
<tr>
<th>Service</th>
<th>Phone Number</th>
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</thead>
<tbody>
<tr>
<td>Pest Control on Campus, for example:</td>
<td></td>
</tr>
<tr>
<td>Rodents, Raccoons, Insects, Birds (live):</td>
<td>893-2661</td>
</tr>
<tr>
<td>Facilities Management</td>
<td></td>
</tr>
<tr>
<td>Dogs (running loose):</td>
<td>681-5285</td>
</tr>
<tr>
<td>County Animal Control</td>
<td></td>
</tr>
<tr>
<td>Marine Animals:</td>
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</tr>
<tr>
<td>Live: Marine Mammal Center</td>
<td>687-3255</td>
</tr>
<tr>
<td>Dead: Fish &amp; Game</td>
<td>548-1776</td>
</tr>
<tr>
<td>Injured Animals:</td>
<td></td>
</tr>
<tr>
<td>Wildlife Care Network</td>
<td>966-9005</td>
</tr>
<tr>
<td>Dead Animals in buildings or on roads:</td>
<td></td>
</tr>
<tr>
<td>County Animal Control</td>
<td>681-5285</td>
</tr>
<tr>
<td>Environmental Health Issues at Home</td>
<td></td>
</tr>
<tr>
<td>County Public Health Department</td>
<td>681-4000</td>
</tr>
<tr>
<td>Food Permits for Student Groups</td>
<td></td>
</tr>
<tr>
<td>Office of Student Life</td>
<td>893-8912</td>
</tr>
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<td>Hot Work Permits</td>
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</tr>
<tr>
<td>Physical Facilities - Indoors</td>
<td>451-8996</td>
</tr>
<tr>
<td>EH85 - Outdoors</td>
<td>893-3785</td>
</tr>
<tr>
<td>Household Hazardous Waste Collection</td>
<td></td>
</tr>
<tr>
<td>Center County of Santa Barbara</td>
<td>882-3602</td>
</tr>
<tr>
<td>Recycling Program</td>
<td></td>
</tr>
<tr>
<td>Associated Students</td>
<td>893-7765</td>
</tr>
</tbody>
</table>

KE, Rev. 8/18/14
Contact information for Lab members and Amanda Strom

See also the Safinya Lab website at http://www.mrl.ucsb.edu/~safinyaweb/

Lab phone numbers: x4859 (MRL labs) and x5726 (CNSI X-ray lab)

<table>
<thead>
<tr>
<th>Name</th>
<th>Office Phone</th>
<th>Cell Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peter Chung</td>
<td></td>
<td>(510) 847 0116</td>
<td>peter.chung@mrl</td>
</tr>
<tr>
<td>Miguel Zepeda-Rosales</td>
<td>x7943</td>
<td>(831) 840 6820</td>
<td>miguelz@mrl</td>
</tr>
<tr>
<td>Kai Ewert</td>
<td></td>
<td>252 4318</td>
<td>ewert@mrl</td>
</tr>
<tr>
<td>Youli Li</td>
<td>x8104</td>
<td>252 6315</td>
<td>youli@mrl</td>
</tr>
<tr>
<td>Ramsey Majzoub</td>
<td></td>
<td>(303) 710 5585</td>
<td>ramsey.majzoub@mrl</td>
</tr>
<tr>
<td>Cyrus Safinya</td>
<td>x8635</td>
<td>708 2591</td>
<td>safinya@mrl</td>
</tr>
<tr>
<td>Bruno Silva</td>
<td></td>
<td>403 8227</td>
<td>bsilva@mrl</td>
</tr>
<tr>
<td>Chaeyeon Song</td>
<td></td>
<td>455 7943</td>
<td>chaeyeon@mrl</td>
</tr>
<tr>
<td>Victoria Steffes</td>
<td></td>
<td>???</td>
<td>vsteffes@chem</td>
</tr>
<tr>
<td>Amanda Strom</td>
<td>x7925</td>
<td></td>
<td>amanda@mrl</td>
</tr>
<tr>
<td>Emily Wonder</td>
<td></td>
<td>(515) 975 6383</td>
<td>emilywonder@umail</td>
</tr>
</tbody>
</table>
Earthquake Safety

There will be a big earthquake in Santa Barbara. The only question is when.

All storage, especially of heavy objects, chemicals and glass, must ensure that the stored materials will not fall and become a hazard, obstruct escape routes or injure someone in a large earthquake. All gas cylinders need to be secured with a welded link metal chain. Furniture taller than 42 inches must be secured to the walls. Alert Amanda Strom, Youli Li or Kai Ewert if you notice unsecured furniture.

During an earthquake, you should try to stand in a doorframe or crouch under a desk until all shaking has stopped and only then evacuate the building.

Lab Safety

Introduction

Welcome to the Safinya Lab!

This document intends to provide you with some essential information that will help you work more efficiently and safely in our lab. In addition, it aims to give you a central repository of useful information, such as contact info for lab members etc. If you have suggestions on what else to include, please let Kai Ewert know.

If there is any safety-pertaining information in this document that you do not understand completely, seek clarification from Kai Ewert or Youli Li (contact information at the beginning of this document).

It almost goes without saying that doing your work in the lab in a way that is professional, safe, environmentally responsible and respectful of the needs of others is the basis for everyone working successfully while at the same time enjoying it. We have students and postdocs from a variety of backgrounds in the lab. Many of them will work in areas new to them. This poses a particular challenge for working safely, be it with biohazards or hazardous chemicals. Thus it is important for more experienced lab members to share their knowledge of how to work safely and efficiently. Everyone needs to work in the safest possible manner, not only to ensure their own and their coworkers' safety, but also to comply with the many laws and regulations about safe work practices that apply to the university environment. In the interest of everyone’s safety, it is further important for all lab workers to be aware not only of the hazards and safety requirements of their own work, but also of that of their coworkers.
It is the responsibility of each and every person working in this lab to do the inquiry, the literature research, and the thought required to understand the hazards of their experimental work before they begin it.

To be allowed to work in the lab, you must complete the required safety training (see below) and complete and file the MRL Participant Form with Sylvia Vogel. This form directs participants to the required safety training beyond laboratory issues including fire, earthquake, ergonomics and more.

Laboratory Worker Responsibilities

For “every individual who works in a UCSB laboratory (employee, student, postdoctoral scholar, faculty member, or other person)” UCSB defines the following responsibilities for safety and environmental compliance:

1. Comply with applicable environmental, health and safety laws and regulations, University policy and accepted safe work practices. Campus policies are found at: http://www.policy.ucsb.edu/
2. Observe environmental, health and safety related signs, posters, warning alarms and written directions.
3. Learn about potential hazards associated with their work and work area; know where information on these hazards is kept for their review; and use this information when needed.
4. Participate in health and safety training applicable to their work situation.
5. Follow procedures and observe precautions for the use of special materials (such as carcinogens, acutely toxic chemicals, radioactive materials or biohazards), as detailed in the laboratory’s use-authorizations, and Lab-specific Chemical Hygiene Plan, and the Safety Data Sheet (SDS) for the material.
6. Always use personal protective equipment and engineering controls (e.g., fume hoods) appropriate to the work and understand their proper operation.
7. Be familiar with the location and general content of the UCSB Emergency Information Flipchart posted in their area. Know the locations of their local safety shower/eyewash, fire extinguishers, first-aid kit and Emergency Assembly Point. Participate in emergency drills.
8. Curtail or stop their work if they reasonably believe continuation of the work poses an imminent danger to health or safety, and immediately notify their supervisor, or Environmental Health & Safety. Warn co-workers about defective equipment and other hazards.
9. Participate in required inspection and monitoring programs.
10. Never work under the influence of substances or circumstances that have adverse effects on cognition.

Safety Training Requirements

Every person working in the lab is required to take the in-person EH&S Laboratory Safety class before starting any work in the laboratory. No lab keys will be issued to you unless you have taken this class and this has been documented.
An in-person class is held at the start of each quarter. In the fall the class is provided for incoming graduate students at several science departments and at the College of Engineering. In summer there is a special class just for interns.

The in-person quarterly training schedule is announced by e-mail one to two weeks before the class and is posted online. Make sure you are on the MRL email lists so you get this and other important announcements.

In addition, there is an online lab safety course available. Lab users may get temporary lab access, until the next in-person class, by completing the online training course and test (see below). They must attend the next available in-person class to retain lab access privileges. Undergraduate lab researchers who work in the lab one quarter or less are only required to take the online lab safety class but are encouraged to take the in-person class.

The online training is accessible via:

http://ehs.ucsb.edu/training/lsvideo.html

In addition to the EH&S class(es), every person working in the lab also has to go through a brief lab-specific training, for which you should see Kai Ewert once you've completed your EH&S class.

Furthermore, all lab users are required to read the safety-related documents listed below and document that they have read them within 2 weeks of starting work in the lab:

- The Chemical Hygiene Plan (CHP) for the Safinya Lab. This is meant to be the main safety resource for the Safinya Lab.

- The MRL Emergency Operations Plan (also Emergency Action Plan & Fire Prevention Plan) (see Appendix C) available at

  http://www.mrl.ucsb.edu/mrl-emergency-operations-plan

- The MRL Combined Injury & Illness Prevention Plan and Hazard Communication Plan available at

  http://www.mrl.ucsb.edu/mrl-injury-illness-prevention-plan

All safety training needs to be documented. Please see Kai Ewert with any records of safety trainings that you have completed.

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 ensure 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. Consult the information below as well as the SOP on “Preparing for a New Project” for more guidance on how to go about this and what resources are available.

**Basic Lab Safety Rules and Precautions**

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/units/labsfty/labsc/inspection/Lab_Self_Inspection_web_Mar2014.pdf](http://www.ehs.ucsb.edu/units/labsfty/labsc/inspection/Lab_Self_Inspection_web_Mar2014.pdf)

**General**

No storage or consumption of food and drink is permitted in the lab. An exception is the area connecting rooms 1012 and 1024 (the “LOM area”), which is not a designated lab area. (No lab work must be performed in the LOM area, and gloves must not be worn when handling anything there.)

No food must be stored in the freezers or refrigerators in the lab. The lab microwave must not be used for food.

Smoking is prohibited anywhere in the lab, including the LOM area.

Do not block lab aisles with chairs, stools, or equipment.

**Lab Equipment**

Some of the equipment in the lab poses dangers when not used properly. This particularly includes the X-ray diffractometers (dangers due to high voltage and ionizing radiation) and the confocal microscope (dangers due to laser radiation). You must receive proper instruction on how to work with these instruments prior to using them.

Instruction manuals for most of the equipment in the lab are kept in the file cabinet next to the door leading from room 1024 (the “prep lab”) to the “LOM area”. The manual for the biosafety cabinet (BSC) in the cell room is on top of the BSC, while microscopy-related manuals are in microscopy lab.

**Electrical Safety**

Below are a few important items pertaining to electrical safety in the lab.

- Circuit breakers for the labs are located in the main hallway, outside of the labs.
- Do not use damaged electrical cords. Have these replaced or repaired properly; do not attempt to do the repair yourself.
- Do not use extension cords in place of permanent wiring, but only on a temporary, immediate, basis. Extension cords must be 14-gauge (heavy duty) at a minimum and must not be run through walls, ceiling or doors.
- Do not chain extension cords or connect them to power strips.
• Power strips must have circuit breakers.
• Keep power strips off the floor: the labs have no floor drains and flooding is a real possibility that may happen for a variety of reasons (e.g. extreme rainfalls or equipment malfunction, both of which have flooded the lab in the past).

Gas cylinder handling

All gas cylinders need to be secured with a 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). Date the cylinder when you place it in the lab.

Chemical Safety

For transport of larger (≥ 1 L) glass bottles with chemicals, use designated carriers or plastic buckets.

A Humorous on Chemical Safety OR What to Look Out For

THE FUME HOOD: Where does it go??

Transporting Chemicals

Always transport chemicals in a manner that minimizes the chance of accidental exposure. Keep bottles closed and minimize the chance that a container might drop and
break. For transport of larger (≥ 1 L) glass bottles with chemicals, use designated carriers or plastic buckets.

Fume Hood Usage

**Always handle volatile and hazardous chemicals in a fume hood.** All fume hoods in the lab have simple airflow indicators. Check these periodically to ensure that the fume hood is working properly. Keep the air slots in the back of the hood free from obstructions. Never tamper with the electronic air flow alarms of the fume hoods in an attempt to permanently override them.

**Always keep fume hood sashes as low as possible.** Keep only items that are in use inside the fume hoods. Several of the hoods have ventilated storage cabinets underneath the hood surface. These, rather than the fume hoods, should be used for storage of hazardous materials.

For additional information on fume hood usage, see the corresponding EH&S fact sheet in Appendix A. The fact sheet is also available on the web at


**Identifying Chemical Hazards**

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; formerly known as Material Safety Data Sheets/MSDS). Widely available online (see the “Resources” part of this section of the CHP, or the corresponding part of section II), 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” part of this section of the 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 1012 next to the door.

- The “Resources” part of this section of the CHP
Chemical safety labels

In 2012, OSHA released an update to the regulation that determines how chemical safety information is relayed to workers. The main changes are standards for safety data sheets (SDS; formerly Material Safety Data Sheets, MSDS) and new chemical labeling which includes hazard-alerting pictograms. These are the pictograms and their meanings:

The update to the regulations also introduced new hazard classes. These may be confusing, because different types of hazards will be ranked by severity, starting with “1” as the most hazardous. But not all classes have the same number of ranking levels, and the severities can not be compared between classes—one class’s category “1” is not necessarily more dangerous than another’s category “2”. The order of rankings is also the reverse of those used on the U.S. National Fire Protection Association diamonds, which use “0” for least and “4” for most hazardous.
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 Kai Ewert or Youli Li (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 the responsible lab member (a list of responsibilities is reproduced below (current as of Oct. 2012) and can also be found in the lab).

<table>
<thead>
<tr>
<th>Diffractometers</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Rigaku Supplies</td>
<td>Miguel</td>
</tr>
<tr>
<td>Ultra-SAXS</td>
<td>Peter</td>
</tr>
<tr>
<td>2C / 4C</td>
<td>Ramsey / Bruno</td>
</tr>
<tr>
<td>2C/4C area cleanup</td>
<td>Miguel + Undergrads</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Microscopes</th>
<th></th>
</tr>
</thead>
<tbody>
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</tr>
<tr>
<td>MRL Scope</td>
<td>Bruno</td>
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<tr>
<td>Inverted</td>
<td>Ramsey</td>
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<tr>
<th>Other</th>
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<tr>
<td>Luminometer</td>
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<tr>
<td>Autoclave</td>
<td>Ramsey</td>
</tr>
<tr>
<td>Cell Lab Maintenance</td>
<td>Ramsey</td>
</tr>
<tr>
<td>Chemical Waste</td>
<td>Kai</td>
</tr>
<tr>
<td>Large Centrifuge</td>
<td>Peter</td>
</tr>
<tr>
<td>Small Centrifuges</td>
<td>Bruno</td>
</tr>
<tr>
<td>Refrigerated Centrifuge</td>
<td>Peter</td>
</tr>
<tr>
<td>Airfuge</td>
<td>Peter</td>
</tr>
<tr>
<td>Computer Maintenance</td>
<td>Peter</td>
</tr>
<tr>
<td>Lipid Prep Vacuum Pump</td>
<td>Kai</td>
</tr>
<tr>
<td>Nitrogen, other gases</td>
<td>Emily</td>
</tr>
<tr>
<td>Ordering</td>
<td>Peter/Emily</td>
</tr>
<tr>
<td>-70°C Freezer</td>
<td>Ramsey/Emily</td>
</tr>
<tr>
<td>LOM Area</td>
<td>TBD</td>
</tr>
<tr>
<td>Eppendorf Pipettes</td>
<td>Peter</td>
</tr>
<tr>
<td>Millipore system</td>
<td>Peter</td>
</tr>
<tr>
<td>pH Meter</td>
<td>Peter</td>
</tr>
<tr>
<td>Incubators</td>
<td>Ramsey</td>
</tr>
</tbody>
</table>
Personal Protective Equipment (PPE)

The following summarizes the requirements (as per UC and MRL policy) about personal protective equipment, i.e., equipment designed to protect workers from laboratory hazards. For quick reference, each laboratory door displays a poster summarizing the UC policy on PPE.

Specific procedures may require specialized protective equipment; for example, you must wear the specialized safety glasses with darkened glass when flame-sealing capillaries for X-ray experiments, and use insulated gloves when handling items in the -70 °C freezer.

You are not allowed to purchase your own PPE. PPE will be provided by UCSB or the laboratory.

Safety Glasses and Other Eye Protection

Safety glasses must be worn at all times when working in an MRL laboratory. Even if you are not working with hazardous materials, someone else in the lab probably is. All eye protection equipment must be American National Standards Institute (ANSI) approved and appropriate for the work being done. The two exceptions to the requirement for safety glasses for our lab are the “LOM area” between 1012 and 1024, which is not a lab space, and when doing microscopy.

Each member of the lab should have their own, personal pair of safety glasses. Regular corrective lenses or sunglasses are NOT safety glasses, nor do contact lenses provide any sort of adequate protection. Increase the likelihood of wanting to wear your safety glasses by getting a pair that is comfortable and keeping them clean and scratch-free, so your vision is as good with as without them. Safety glasses will be part of the PPE you are given when you begin work in the laboratory. You can also get safety glasses in the storerooms, by ordering from Fisher, or by taking one of the spare pairs (see below).

Spare / extra safety glasses and some specialty safety glasses are in the top drawers of the cabinets located on your left as you enter room 1012.

Face shields (for splash protection) are kept on the side of the single hood in room 1024 (see “Communal PPE” below).

Clothing requirements

Full-length pants, or equivalent, must be worn at all times while working in or occupying any laboratory area (i.e., legs must be covered by clothing). The area of skin between the shoe and ankle should not be exposed.

The MRL recommends that lab users wear non-synthetic (cotton) clothing. Cotton (or other non-synthetic material) clothing is mandatory (underneath a flame-resistant lab coat) when working with highly flammable liquids or pyrophorics, to minimize injury in the case of a fire emergency.
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, and a regular lab coat or a lab coat with elastic cuffs when working in the Cell Lab. Do not wear lab coats in the LOM. Note that “standard” labcoats 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 prevent skin exposure while wearing gloves. Some spare lab coats are available in the lab if needed, check with Kai Ewert.

Lab coats must not be cleaned at home or 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.

For additional (but partly outdated) information on lab coats, see the corresponding EH&S fact sheet in Appendix A. The fact sheet is also available on the web at

http://ehs.ucsb.edu/units/labsfty/labrsct/actsheets/Lab_Coats_FS35.pdf

Communal PPE

Certain PPE items are used so rarely that they are not handed out to each individual lab member. Rather, they are available to everyone as communal PPE in the lab. These items and their locations are as follows:

- **Splash apron**
  A splash apron, for body protection against splashes (to be used when handling very large volumes of hazardous liquids or for other procedures with high splash potential), is kept next to the door from room 1024 to the hallway (on your right as you enter the lab) – see the picture below.
• **Face shields**
  Face shields, for eye and face protection from splashes, are kept on the side of the single hood in room 1024 (on your left right as you enter 1024 from the LOM) – see the picture below.
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/safety/labsafety/labglove.htm

In Appendix B, you can find tables with resistance data for gloves available from the campus storerooms (from the EH&S website). Note that the various charts don’t always agree with each other. Below is another glove selection chart, one which makes the most sense from a chemical intuition point of view. Be careful trusting any of these charts and remember that the best protection is to not spill anything in the first place! (Text and chart downloaded on Aug 14, 2014 from

Glove Selection Chart

Glove Selection Chart With Chemical Breakthrough Ratings

The below glove selection chart is provided by All Safety Products as a general guide for glove selection in relation to chemicals handled. The information presented here is believed to be accurate; however, we cannot guarantee its accuracy. In any case, where there is a hazardous condition, we recommend that you consult with a certified safety professional. Many factors affect the breakthrough times of glove materials including, but not limited to:

1. Thickness of glove material
2. Concentration of the chemical worked with
3. Amount of chemical the gloves come in contact with
4. Length of time which the glove is exposed to the chemical
5. Temperature at which the work is done
6. Possibility of abrasion or puncture.

This information is provided as a guide to proper glove material selection. Glove performance varies between manufacturers, so always give yourself extra time and do not push glove strength to the estimated limits and consult a certified safety consultant when in doubt to make sure you have the right glove for your application.
# Chemical Resistance Chart

This Chemical Resistance Chart is intended to provide general information about the reactions of different glove materials to the chemicals listed. SAS Safety gloves have not been individually tested against these chemicals. Variability in glove thickness, chemical concentration, temperature, and length of exposure to chemicals will affect the performance.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Neoprene</th>
<th>Nitrile</th>
<th>Latex</th>
<th>PVC</th>
<th>Chemical</th>
<th>Neoprene</th>
<th>Nitrile</th>
<th>Latex</th>
<th>PVC</th>
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<td>NR</td>
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<td>C</td>
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<td>Isoadipic Acid*</td>
<td>G</td>
<td>E</td>
<td>E</td>
<td>G</td>
<td>Turpentine</td>
<td>G</td>
<td>E</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>Hydrogen Peroxide</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>Vegetable Oil</td>
<td>E</td>
<td>E</td>
<td>P</td>
<td>F</td>
</tr>
<tr>
<td>Hydroquinone</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>Xylene</td>
<td>G</td>
<td>G</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Isocyanatopropylene</td>
<td>F</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>Xylene</td>
<td>P</td>
<td>G</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>iso-Octane</td>
<td>E</td>
<td>E</td>
<td>NR</td>
<td>P</td>
<td>Xylene</td>
<td>P</td>
<td>E</td>
<td>NR</td>
<td>P</td>
</tr>
<tr>
<td>Isopropyl Alcohol*</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>G</td>
<td>Xylene</td>
<td>P</td>
<td>E</td>
<td>NR</td>
<td>P</td>
</tr>
</tbody>
</table>

*Warning:* Protective gloves and other protective apparel selection must be based on the user's assessment of the workplace hazards. Gloves and Apparel materials do not provide unlimited protection against all chemicals. It is the user's responsibility to determine before use that the Glove and Apparel will resist permeation and degradation by the chemicals (including chemical mixtures) in the environment of intended use. Failure by the user to select the correct protective gloves can result in injury, sickness, or death.

Material contained on this chart is copyrighted. Please call All Safety Products if you have any questions at 562-630-3700 or visit our website, www.allsafetyproducts.com.
There are several places in the lab where we keep latex and nitrile single use examination gloves. While impermeable to water, buffers, acids and bases, neither of these gloves are very impermeable to most solvents. This means that you should *immediately* and *quickly* remove the gloves if you spill solvent on them. For increased safety, you might want to wear two pairs of gloves on top of each other. This will slow the permeation through the gloves down somewhat. Extremely impermeable (and clumsy) “barrier” gloves are available from the Physics storeroom. The single-use gloves are available from the storerooms or via Fisher.

You must take off your gloves as soon as you are no performing lab work, e.g. when you answer the telephone, operate a door handle or use a computer keyboard in the lab. As mentioned above, the “LOM area” is the only area where food and drink may be kept and eaten. This is why you *must take off your gloves* when doing anything in the LOM (e.g. using the computer).

Gloves for protection from heat and cold are also available in the lab, usually next to the ovens and the -70 °C freezer.

**The Laboratory Hazard Assessment Tool (“LHAT”)**

Before beginning work in the lab, you will have to use LHAT to learn about the hazards in the labs you will use and the required PPE. LHAT is a web-based system intended to identify and communicate hazards present in a lab or research area. Once hazards are identified, lab members can take appropriate Personal Protective Equipment (PPE) training and receive PPE appropriate for their work. You can log in to LHAT at

[https://ehs.ucop.edu/lhat/](https://ehs.ucop.edu/lhat/)

Because of the different hazards present in them, the Safinya labs in the MRL are divided into three sections in LHAT: the Main MRL Labs, the Cell Lab, and the LOM. For reference, the certified laboratory hazard assessments for the three labs (current as of Aug 13, 2014) are attached to this CHP as Appendix F. The recommended PPE for the three labs is listed below.
Main MRL Labs

<table>
<thead>
<tr>
<th>Personal Protective Equipment</th>
<th>Custom Laboratory Activity PPE</th>
<th>Shared Protective Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Closed toe/heel shoes</td>
<td></td>
<td>• Flame-resistant (FR) outer gloves</td>
</tr>
<tr>
<td>• Full-length pants or equivalent</td>
<td></td>
<td>• Chemical-resistant apron</td>
</tr>
<tr>
<td>• Chemical splash goggles</td>
<td></td>
<td>• Face shield</td>
</tr>
<tr>
<td>• Safety glasses</td>
<td></td>
<td>• Disposable gloves</td>
</tr>
<tr>
<td>• Lab coat</td>
<td></td>
<td>• Thermal protective gloves (impermeable insulated gloves for liquids and steam)</td>
</tr>
<tr>
<td>• Flame resistant lab coat (NFPA 2112)</td>
<td></td>
<td>• Cryogenic protective gloves</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Shoe covers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Possibly warm clothing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Optical density and wavelength-specific safety glasses based on individual beam parameters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Chemical-resistant gloves</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cut-resistant gloves</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Impermeable or chemical resistant gloves</td>
</tr>
</tbody>
</table>

Notes:

• In all cases, chemical splash goggles can be substituted for safety glasses and provide a higher level of protection when working with large quantities of material. For splash or impact protection, either chemical splash goggles or safety glasses need to be worn under face shields.
Cell Lab

<table>
<thead>
<tr>
<th>Personal Protective Equipment</th>
<th>Custom Laboratory Activity PPE</th>
<th>Shared Protective Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Closed toe/heel shoes</td>
<td>• Double layer disposable gloves</td>
<td></td>
</tr>
<tr>
<td>• Full-length pants or equivalent</td>
<td>• Face shield</td>
<td></td>
</tr>
<tr>
<td>• Chemical splash goggles</td>
<td>• Disposable gloves</td>
<td>• Thermal protective gloves</td>
</tr>
<tr>
<td>• Safety glasses</td>
<td>• Eye and mucous membrane protection (as appropriate for operations)</td>
<td></td>
</tr>
<tr>
<td>• Lab coat</td>
<td>• Thermal protective gloves (impermeable insulated gloves for liquids and steam)</td>
<td></td>
</tr>
<tr>
<td>• Barrier lab coat impervious to fluids</td>
<td>• Cryogenic protective gloves</td>
<td>• Chemical-resistant gloves</td>
</tr>
<tr>
<td></td>
<td>• Disposable gloves</td>
<td>• Cut-resistant gloves</td>
</tr>
</tbody>
</table>

Notes:
- In all cases, chemical splash goggles can be substituted for safety glasses and provide a higher level of protection when working with large quantities of material. For splash or impact protection, either chemical splash goggles or safety glasses need to be worn under face shields.

LOM area

No PPE is recommended. This laboratory has been designated and posted as free of chemical, physical, biological, radiological, laser, and non-ionizing hazards.
Fridges and Freezers

There are a number of fridges and freezers in the lab. Only one of them (across from the fume hood in 1012) is designed for the storage of flammables. This (clearly labeled) fridge is the only fridge where flammable liquids may be stored, and its use for items that do not require a fridge that is designed for storage of flammables should be minimized. *No food or drink must be stored in any of the fridges in the lab.*

Take care when using the -70 °C freezer in 1032. Always wear the appropriate insulated gloves (typically stored on top of the freezer) to avoid frostbite or your fingers getting stuck to contents in the fridge or its walls. Minimize the time that this freezer is opened, as moisture from the air rapidly condenses on it.

Some Best Lab Practices

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

- Return 4 L solvent bottles to the storage cabinet at the end of the day. Don’t leave them in the hood or on the bench top
- 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
- Empty rotavap solvent traps when you are done
- Label all your bottles/flasks with proper chemical names. Preferably use pencil on tags, not a marker
- 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

Using Eppendorf-type pipettes:

To increase the accuracy of your experiments as well as the lifetime of these expensive instruments, follow the simple guidelines below.

- Only the pipette tip and *never* the shaft is immersed in the solution being aliquoted from. If at any point in time you do contaminate the shaft either during sample aspiration, or by placement of the pipette into the solution, clean the shaft
immediately. The shaft must be clean to prevent sample cross-contamination and corrosion of the metal tip ejector

- The different pipette types (regular vs. trigger) each require specific pipette tips. If the tip doesn't fit right, sample aspiration is inaccurate

- *Never* adjust the pipette volume above the designated upper limit or below the lower limit; not only are the pipettes inaccurate outside of the designated range, this also damages the instrument. The following are the upper and lower limits for each pipette:
  
  \[
  \begin{align*}
  \text{P2:} & \quad 0.1\mu\text{L} - 2\mu\text{L} \\
  \text{P10:} & \quad 0.5\mu\text{L} - 10\mu\text{L} \\
  \text{P20:} & \quad 2\mu\text{L} - 20\mu\text{L} \\
  \text{P200 (trigger):} & \quad 20\mu\text{L} - 200\mu\text{L} \\
  \text{P200 (general):} & \quad 50\mu\text{L} - 200\mu\text{L} \\
  \text{P1000:} & \quad 200\mu\text{L} - 1000\mu\text{L}
  \end{align*}
  \]

- If a specific pipette is not in full working order (e.g. the thumbwheel does not move smoothly, the pipette is not aspirating the correct volume, the tip ejector is corroded) contact the lab member responsible for the maintenance of the pipettes right away

- When using these pipettes to measure organic solvents, special considerations apply. The relatively high vapor pressure of many common organic solvents (e.g. methanol, chloroform) can result in buildup of pressure after the solvent is aspirated. This leads to dripping (which also tends to be more pronounced due to the lower surface tension (compared to water) of these solvents), and therefore to volume inaccuracies. Aspirating and ejecting a few times before transferring the liquid usually solves this problem. Another potential problem is the lack of resistance of plastic tips to organic solvents. Only polypropylene tips must be used, and the time of contact between solvent and tip material must be minimized to avoid contamination.

**Labeling of Samples, Solutions etc.**

As a general rule, all samples, custom-made solutions, etc. must be labeled with the name of the owner, date prepared, and complete chemical name(s). While this ideal may not always be achievable, the absolute minimum (e.g. for small containers) is to label the holder / large container with the name of the owner, the date and if applicable information about any particular hazards (e.g. “ethidium bromide – highly toxic”). The more hazardous the material and the longer the container will be around, the more complete the labeling must be. If necessary, use a labeled sample holder or secondary container that is more completely labeled. This also has the advantage that it can be reused for similar samples at a later point.
It is best practice to label containers containing purchased chemicals with your initials, date received, and date opened (e.g. “KE Rcd. 9/09, Op. 10/09”). See also the SOP on Chemical Storage, in particular the information on time-sensitive chemicals.

Lab Safety Equipment

Below are the locations of emergency showers and eyewash stations in the lab as well as basic directions for their use.

Emergency Showers and Eyewash Stations

Outside of the doors of rooms 1012 and 1024 are emergency showers with eyewash stations. Most of the sinks also have some setup that may be used as an improvised eyewash station. Do not use the emergency showers unless there is an actual emergency. Facilities management (x8300) needs to be called to turn them off once activated.

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 as a first aid measure. 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.

Spills and Exposure to Hazardous Chemicals

For all incidents in which injury has occurred or may be imminent, follow the steps below.

Emergency procedure

• Evacuate the area if needed for safety
• Administer First Aid as needed
• Warn people in the area
• Notify emergency services (call 9-911 from campus phones, or 805 893 3446 from cell phones2)
• Notify Kai Ewert as soon as feasible

First Aid After Exposure to Hazardous Chemicals

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 as a first aid measure. 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.

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2 simply calling 911 from a cell phone will not contact UCSB dispatch, but rather the Ventura dispatch, possibly causing delays
are also flushed with water for five minutes as a first aid measure. 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.

**Spill Cleanup**

See the SOP on Chemical Spill Cleanup for information on when and how to clean up a chemical spill (page 99).

**Disposal of Hazardous Waste**

To prevent injury, minimize environmental health hazards, and meet regulatory requirements, all hazardous waste must be disposed of in compliance with UCSB chemical waste disposal procedures. Individuals may be held criminally liable for violations of applicable laws and regulations.

For additional information, see the EH&S fact sheets on Chemical Waste Disposal and Sharps Disposal in Appendix A. These fact sheets are also available on the web at

http://ehs.ucsb.edu/units/labsfty/labsc/factsheets/lsfacsheets.htm

An online refresher course on hazardous waste is available at

http://ehs.ucsb.edu/4DAction/WebCourseDescription/100696/0

**Chemical Waste Disposal**

*Do not dump any hazardous substances down the drain!!! Do not dispose of chemicals in trash cans.*

Do not leave chemical waste in open containers in the fume hood. Waste containers must be capped if not in use. Note that the cap on the Acid Waste container in the lab should only be loosely tightened to prevent the buildup of pressure. Do not use fume hoods to intentionally evaporate chemicals.

**Proper Hazardous Waste Segregation**

The lab’s chemical waste is segregated in order to avoid violent reactions of incompatible chemicals. If you are not absolutely sure about where your specific waste can and needs to go, contact Kai.

- Segregate solids, liquids, and gases
• If your waste falls in one of the following categories (or you are not sure whether it does), request that a new collection container be started for it (contact Kai or the lab member responsible for chemical waste):
  o Strong oxidizers
  o Peroxide-forming chemicals
  o Cyanides
  o Alkaline solutions of pH <12.5
  o Chemical carcinogen
  o Alkali metals and other water reactives
  o Unstable chemicals
  o Heavy metal solutions and salts
  o Other toxic materials

Collecting and Storing Hazardous Waste

Chemical waste must only be stored in the lab’s designated Hazardous Waste Storage Area in one of the hoods in room 1024

When adding waste to the common collection bottles (solvent wastes, acid waste), please make sure to enter the amount and composition of your waste on the provided lists.

Other chemical waste storage requirements:
• Store chemical waste in appropriate containers (containers designed for storage of chemicals). Suitable empty bottles (4 L solvent bottles) are stored on a shelf next to the door to the confocal microscope hutch (room 1032). Check with Kai for smaller bottles.
• Containers must be completely sealed to prevent spillage. Remember, however, that the cap on the Acid Waste container should only be loosely tightened to prevent the buildup of pressure.
• Liquid waste must be in screwtop containers, and the containers must not be filled over 80%.
• Outside surfaces of containers must be clean and free of contamination.

Labeling Hazardous Waste

Use the official UCSB hazardous waste labels and provide all the requested information (link to PDF file with labels: http://www.ehs.ucsb.edu/units/hw/hwrsc/hwpdf/labelcutout2004.pdf): Labels are available for free in the storerooms, and we usually have a stock of these labels at hand in the cabinet above the cleaning bath in 1012.
• Waste must be identified by chemical name (no abbreviations)
• All constituents in solid and liquid mixtures must be identified, and their concentrations stated to the extent possible
• Identify the chemical hazard classification(s) of the waste (e.g. flammable, corrosive, oxidizer, etc.)
Any original/existing labels must be defaced by either removal or lining out
Date containers. Hazardous waste containers must be disposed of in a timely manner. Under no circumstances must hazardous waste containers be stored for more than 9 months

Proper Waste Disposal / EH&S Pickup

Whenever a waste container is about 75% full, notify the group member responsible for waste disposal or Kai so that pickup by EH&S can be arranged.

Briefly, here is how to arrange for pickup of the waste by EH&S:
Fill out a UCSB Waste Pickup Request Form (PDF) and send it to EH&S via campus mail or fax it to 893-7259 (please do not call EH&S). To electronically send a waste pickup request, visit http://ehs.ucsb.edu/hazwasterequest

Notes:
- 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 disposal

Sharp materials (such as broken glass, razor blades, or hypodermic needles) may not be placed in the regular lab trash as this could injure the custodian. See below for proper disposal procedures. Depending on their size, other sharp materials may be disposed as described for broken glass (large items) or needles and razorblades (small items).

Glass Disposal

All glass (except recycling) must go into the designated glass disposal containers in the lab. These are white and blue cardboard boxes with a plastic lining.

When the container is full: take the lid off, flip the cover over the opening and place the lid back on the container. Then use duct tape to secure the lid and to prevent the container from rupturing during handling. Finally, dispose of the container in one of the designated “Sharps” bins (the closest ones are next the the MRL gas cage at the back of the MRL and across from the Physics machine shop at the front of the MRL); you will need a key to open these bins—this is kept on top of the toolbox in room 1012. New glass disposal containers are available, e.g., from the physics storeroom or from Fisher.

Disposal of Razor Blades, Needles, etc.

Our lab has a supply of plastic containers specifically designed for the disposal of razor blades and hypodermic needles. Typically, one of these is available in the hood next to the sink in room 1024. A supply of these containers is in a drawer next to the sink in
1024. When the container is full, close the lid tightly (it should snap into place), secure with duct tape, and discard the container into a glass trash bin.

**Completing Work in the Lab – A Checklist**

On finishing your work and your stay in the Safinya Lab at UCSB, you will need to make way for the next person and put your gear back into circulation. Please do the following:

**Get Started**

- Let Kai know when you are leaving a few weeks before you are gone. He'd much rather help you clean if you feel you don't have sufficient time just before you leave then discover unlabeled samples/chemicals a few years down the road

**Get Clear**

- Dispose of most of your samples (don’t forget about your microscopy samples if you have them). A select few may be archived
  - Consider whether anybody will really ever want to look at the samples again. Almost none of the current old sample archive has ever been accessed by anybody
- For samples to be archived:
  - Label these samples extra-well
  - Place them in the smallest cardboard box possible
  - Write your name prominently on the outside along with basic info about the samples
  - Place a spreadsheet detailing what the samples are in that same box
  - Add a large-lettered note on top of the box identifying any hazardous materials in the box / the samples
  - Store the box as the samples dictate (lab, fridge, or freezer)
- Put “personal” chemicals, labware, capillaries back into circulation
- Clear and clean your bench space
- Clear out your personal drawers in the lab. Any equipment that has been assigned to you should be put back into circulation
- Clear out your items in the fridge(s)
  - Main fridge
  - Cell lab fridges / Protein fridge
- Clear out your items in the freezer(s)
  - Regular freezer
  - Lipid freezer / -70°C freezer
- Clear out your items in the cell lab
- Any reagents in your possession should go back to the appropriate chemical storage area or to someone in the group
- Make sure all waste you have generated is transferred to the waste storage area in accordance with the lab’s waste disposal procedures
Checklist:

- Archive the data on your computer and also leave it in its original place
- Hand your labbooks over to the person continuing work on your project, or archive them on the shelves in room 1032
- Go through the shelves, cabinets, and drawers in your office and take, pass on, or dispose of all that’s yours

Stay Connected

- Give Kai your new contact information, most importantly a permanent email address – both for the alumni webpage and to enable future lab members to contact you about your work here. You may also want to connect on LinkedIn, which makes it easy to stay in touch and for us to keep up to date with your post-UCSB career.
Standard Operating Procedures (SOPs)

Background: Standard Operating Procedures

Per the 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 Particularly Hazardous Substances (PHS), namely, “Select” Carcinogens, Highly acute toxins, and Reproductive toxins (for a list, see http://ehs.ucsb.edu/units/labsfty/labsc/chemistry/lshphazsubstance.htm)

- Other “high-hazard” chemical operations

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.
SOP: Use of Acrylonitrile

NOTE: Acrylonitrile (aka vinyl cyanide, ACN) is classified as a Particularly Hazardous Substance (PHS) per Cal-OSHA, since it is listed as a “Select” Carcinogen.

Date of last revision to SOP: Aug. 2014 – Kai Ewert

PI approval of SOP:

_________________________ (C. R. Safinya) ______________ Date

Scope of SOP

Use of acrylonitrile in chemistry procedures in the lab

Compound information

Acrylonitrile (also called vinyl cyanide) is a highly flammable chemical. It is toxic if inhaled, ingested or absorbed through skin. It can undergo explosive polymerization when exposed to heat, light, strong acid, or strong bases. It can form explosive mixtures with air or other strong oxidizers. See the appended LCSS for more information.

Components of the hazardous decomposition of acrylonitrile exposed to fire include carbon oxides, nitrogen oxides, and hydrogen cyanide.

Acrylonitrile is toxic if inhaled; it is extremely destructive to the tissue of the mucous membranes and upper respiratory tract. It may cause allergy or asthma symptoms, breathing difficulties, or respiratory irritation if inhaled. It may be fatal if absorbed through skin. Causes skin burns. Causes eye burns. Toxic if swallowed. A potential carcinogen.

Approval Required

Anyone working for the first time with acrylonitrile in this laboratory must consult with Dr. Kai Ewert. Users must study the relevant safety information and be aware of the appropriate waste disposal method (via non-halogenated solvent waste).

General precautions

Avoid contact with skin, eyes and clothing. Avoid inhalation of vapor or mist. Wash hands before breaks and immediately after handling acrylonitrile.
Personal Protective Equipment

Users of acrylonitrile shall employ the following:

- **Protective eyewear**
  ANSI-approved, tight-fitting safety glasses/goggles must be worn at all times. For procedures with splash potential, a face shield (available in the lab on the side of the single hood in room 1024) should be used.

- **Lab coat etc.**
  Use of a flame-resistant (“blue”) lab coat is mandatory, as are long pants and closed-toe shoes.

- **Lab gloves**
  Standard latex or nitrile gloves do not provide adequate protection from acrylonitrile spills. As per UCSB EH&S, only Butyl and Viton gloves offer protection, but “Barrier” type gloves should also work. A small stock of “Barrier” type gloves is usually at hand in the cabinet in room 1032; these gloves are also available from the Physics storeroom. Wash hands after use of acrylonitrile.

Engineering/Ventilation Controls

Acrylonitrile must be handled in a **fume hood**. Use on the open bench is prohibited.

When outside of the fume hood, containers must be sealed. The use of acrylonitrile on an open lab bench, in open containers, will likely result in worker exposures above the Cal-OSHA legal/safe limits for acrylonitrile.

Handling, Storage, Cleanup, First Aid, and Disposal Requirements

- **Handling:**
  Work with acrylonitrile must be performed in the laboratory fume hoods. Avoid contact with skin, eyes and clothing. Avoid inhalation of vapor or mist. Wash hands before breaks and immediately after handling the product. Acrylonitrile is a highly flammable liquid and vapor that should be kept away from heat, sparks, open flames, and hot surfaces. Wash hands after use of acrylonitrile.

- **Storage:**
  Acrylonitrile must be stored in completely-sealed containers in one of the “Flammables” storage cabinets underneath the fume hoods or in the fridge approved for storage of flammables. Store in the dark or protect from light with aluminum foil. If possible, use original container for storage.
• **Spills/Cleanup:**

Spills of acrylonitrile must be cleaned up as rapidly and completely as possible. Assess the extent of danger. Help contaminated or injured persons. Evacuate the spill area. Avoid breathing vapors. If possible, confine the spill to a small area using a spill kit or absorbent material. Keep others from entering contaminated area (e.g., use caution tape, barriers, etc.).

Place leaking containers in a fume hood. If it can be done safely, clean up small spills with absorbent material (e.g. paper towels) and collect all contaminated materials (including gloves) in a tight-closing container. Make sure to wear “Barrier” type gloves if cleaning up a acrylonitrile spill. A small stock of “Barrier” type gloves is usually at hand in the cabinet in room 1032; these gloves are also available from the Physics storeroom. For larger spills that can not be safely and completely handled by lab personnel, leave the area and contact EH&S at x3194. Follow the procedures for emergencies outlined in the beginning of the CHP and in the SOP for chemical spills.

• **First Aid:**

Call 9-911 (from campus phones, else 911) for immediate medical attention.

**If inhaled**
Move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

**In case of skin contact**
Take off contaminated clothing and shoes immediately. Wash skin with soap and plenty of water. Use the lab emergency shower/eyewash or a faucet as appropriate. Take victim immediately to hospital. Consult a physician.

**In case of eye contact**
Check for and remove any contact lenses. Rinse thoroughly with plenty of water for at least 15 minutes (lifting upper and lower lids occasionally). Use the lab emergency shower/eyewash or a faucet as appropriate. Consult a physician. Continue rinsing eyes during transport to hospital.

**If swallowed**
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

• **Disposal:**

All acrylonitrile wastes must be disposed of through EH&S as non-halogenated solvent waste. No acrylonitrile must go into the sewer system, trash or be allowed to freely evaporate.

**Additional Information**

For additional information on acrylonitrile and its hazards, see the LCSS for acrylonitrile (appended to this SOP).
## LCS for ACRYLONITRILE

### LABORATORY CHEMICAL SAFETY SUMMARY: ACRYLONITRILE

| Substance | Acrylonitrile  
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>(Vinyl cyanide, 2-propenenitrile, cyanoethylene, ACN)</td>
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</tr>
<tr>
<td>Formula</td>
<td>H₂C = CH-CN</td>
</tr>
<tr>
<td>Physical Properties</td>
<td>Colorless liquid</td>
</tr>
<tr>
<td>bp</td>
<td>77 °C, mp -82 °C</td>
</tr>
<tr>
<td>Moderately soluble in water (7.3 g/100 mL)</td>
<td></td>
</tr>
<tr>
<td>Odor</td>
<td>Mild pyridine-like odor at 2 to 22 ppm</td>
</tr>
<tr>
<td>Vapor Density</td>
<td>1.83 (air = 1.0)</td>
</tr>
<tr>
<td>Vapor Pressure</td>
<td>100 mmHg at 22.8 °C</td>
</tr>
<tr>
<td>Flash Point</td>
<td>-1 °C</td>
</tr>
<tr>
<td>Autoignition Temperature</td>
<td>481 °C</td>
</tr>
<tr>
<td>Toxicity Data</td>
<td>LD₅₀ oral (rat) 78 mg/kg</td>
</tr>
<tr>
<td></td>
<td>LD₅₀ skin (rabbit) 250 mg/kg</td>
</tr>
<tr>
<td></td>
<td>LC₅₀ inhal (rat) 425 ppm (4 h)</td>
</tr>
<tr>
<td></td>
<td>PEL (OSHA) 2 ppm</td>
</tr>
<tr>
<td></td>
<td>TLV-TWA (ACGIH) 2 ppm—skin</td>
</tr>
<tr>
<td>Major Hazards</td>
<td>Probable human carcinogen (OSHA &quot;select carcinogen&quot;); moderate acute toxicity; highly flammable.</td>
</tr>
<tr>
<td>Hazard Class(es)</td>
<td>Highly flammable, toxic, potentially explosive, carcinogen</td>
</tr>
<tr>
<td>Toxicity</td>
<td>Acrylonitrile is classified as moderately toxic by acute exposure through oral intake, skin contact, and inhalation. Symptoms of exposure include weakness, lightheadedness, diarrhea, nausea, and vomiting. Acrylonitrile is severely irritating to the eyes and mildly irritating to the skin; prolonged contact with the skin can lead to burns.</td>
</tr>
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</table>
Acrylonitrile is mutagenic in bacterial and mammalian cell cultures and embryotoxic/teratogenic in rats at levels that produce maternal toxicity. Acrylonitrile is carcinogenic in rats and is regulated by OSHA as a carcinogen (29 CFR 1910.1045). Acrylonitrile is listed in IARC Group 2A ("probable human carcinogen") and is classified as a "select carcinogen" under the criteria of the OSHA Laboratory Standard.

**Flammability and Explosibility**
Highly flammable liquid (NFPA rating = 3). Vapor forms explosive mixtures with air at concentrations of 3 to 17% (by volume). Hazardous gases produced in fire include hydrogen cyanide, carbon monoxide, and oxides of nitrogen. Carbon dioxide or dry chemical extinguishers should be used to fight acrylonitrile fires.

**Reactivity and Incompatibility**
Violent reaction may occur on exposure to strong acids and bases, amines, strong oxidants, copper, and bromine. Violent polymerization can be initiated by heat, light, strong bases, peroxides, and azo compounds.

**Storage and Handling**
[...] work with acrylonitrile should be conducted in a fume hood to prevent exposure by inhalation, and splash goggles and impermeable gloves should be worn at all times to prevent eye and skin contact. Acrylonitrile should be used only in areas free of ignition sources. Containers of acrylonitrile should be stored in secondary containers in the dark in areas separate from oxidizers and bases.

**Accidents**
In the event of skin contact, immediately wash with soap and water and remove contaminated clothing. In case of eye contact, promptly wash with copious amounts of water for 15 min (lifting upper and lower lids occasionally) and obtain medical attention. If acrylonitrile is ingested, obtain medical attention immediately. If large amounts of this compound are inhaled, move the person to fresh air and seek medical attention at once.

In the event of a spill, remove all ignition sources, soak up the acrylonitrile with a spill pillow or absorbent material, place in an appropriate container, and dispose of properly. Evacuation and cleanup using respiratory protection may be necessary in the event of a large spill or release in a confined area.
**Documentation of Training**

(signature of all users is required)

- Prior to conducting any work with acrylonitrile, you must have received training specific to the hazards involved in working with this substance.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.

I have read and understand the content of this SOP, and have received any additional specific training that I deem necessary:

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SOP: Use of Benzene

NOTE: Benzene (aka Benzol, PhH) is classified as a Particularly Hazardous Substance (PHS) per Cal-OSHA, since it is listed as a “Select” Carcinogen.

Date of last revision to SOP: Aug. 2014 – Kai Ewert

PI approval of SOP:

_________________________ (C. R. Safinya) ______________ Date

Scope of SOP

Use of benzene in chemistry procedures in the lab

Compound information

Benzene (aka Benzol, PhH) is a mutagen and an OHSA regulated carcinogen. It is a colorless, flammable organic solvent with a sweet smell.

Benzene may be harmful if inhaled; causes respiratory tract irritation; may be harmful if absorbed through skin; causes skin and eye irritation; may be harmful if swallowed. Benzene is an aspiration hazard if swallowed – it can enter lungs and cause damage.

Approval Required

Anyone working for the first time with benzene in this laboratory must consult with Dr. Kai Ewert. Users must study the relevant safety information and be aware of the appropriate waste disposal method (via non-halogenated solvent waste).

General precautions

Avoid contact with skin, eyes and clothing. Avoid inhalation of vapor or mist. Keep away from sources of ignition. Take measures to prevent the buildup of electrostatic charge. Wash hands before breaks and immediately after handling benzene.

Personal Protective Equipment

Users of benzene shall employ the following:

- Protective eyewear
ANSI-approved, tight-fitting safety glasses/goggles must be worn at all times. For procedures with splash potential, a face shield (available in the lab on the side of the single hood in room 1024) should be used.

- **Lab coat etc.**
  Use of a flame-resistant ("blue") lab coat is mandatory, as are long pants or equivalent and closed-toe shoes.

- **Lab gloves**
  Standard latex or nitrile gloves do not provide adequate protection from benzene spills. As per UCSB EH&S, only Viton, Polyvinyl Alcohol, or “Barrier” gloves offer protection. Note that Polyvinyl Alcohol is a water soluble polymer, so use caution when also handling aqueous solutions. A small stock of “Barrier” type gloves is usually at hand in the cabinet in room 1032; these gloves are also available from the Physics storeroom.

**Engineering/Ventilation Controls**

Benzene must be handled in a **fume hood**. Use on the open bench is prohibited.

When outside of the fume hood, containers must be sealed. The use of benzene on an open lab bench, in open containers, will likely result in worker exposures above the Cal-Osha legal/safe limits for benzene.

**Handling, Storage, Cleanup, First Aid, and Disposal Requirements**

- **Handling:**
  Work with benzene must be performed in the laboratory fume hoods.

- **Storage:**
  Benzene must be stored in completely-sealed containers in one of the “Flammables” storage cabinets underneath the fume hoods.

- **Spills/Cleanup:**
  Spills of benzene must be cleaned up as rapidly and completely as feasible. Assess the extent of danger. Help contaminated or injured persons. Evacuate the spill area. Avoid breathing vapors. If possible, confine the spill to a small area using a spill kit or absorbent material. Keep others from entering contaminated area (e.g., use caution tape, barriers, etc.). Place leaking containers in a fume hood. If it can be done safely, clean up small spills with absorbent material (e.g. paper towels) and collect all contaminated materials (including gloves) in a tight-closing container. Make sure to wear “Barrier” type gloves if cleaning up a benzene spill. A small stock of “Barrier” type gloves is usually at hand in the cabinet in room 1032; these gloves are also
available from the Physics storeroom. For larger spills that can not be safely and completely handled by lab personnel, leave the area and contact EH&S at 3194. Follow the procedures for emergencies outlined in the beginning of the CHP and in the SOP for chemical spills.

- **First Aid:**

  Call 9-911 (from campus phones, else 911) for immediate medical attention.

  **If inhaled**
  Move person into fresh air. If not breathing, give artificial respiration and call emergency services. Seek medical attention if needed.

  **In case of skin contact**
  Take off contaminated clothing and shoes immediately. Minor skin contact requires washing with soap and water. Soaking or flushing contaminated areas of the skin with water for periods up to 15 minutes is required if a large area comes into contact with benzene, or if prolonged contact occurs. Use the lab emergency shower/eyewash or a faucet as appropriate. Consult a physician.

  **In case of eye contact**
  Check for and remove any contact lenses. Rinse thoroughly with plenty of water for at least 15 minutes (lifting upper and lower lids occasionally). Use the lab emergency shower/eyewash or a faucet as appropriate. Consult a physician. Continue rinsing eyes during transport to hospital.

  **If swallowed**
  Give milk or water to induce vomiting if conscious. Never give anything by mouth to an unconscious person. Rinse mouth with water. Get medical attention immediately.

- **Disposal:**

  All benzene wastes must be disposed of through EH&S as non-halogenated solvent waste. No benzene must go into the sewer system, trash or be allowed to freely evaporate.

**Additional Information**

For additional information on benzene and its hazards, see the LCSS for benzene (appended to this SOP) and the EH&S fact sheets in Appendix A. The fact sheet is also available on the web at

**LCSS for BENZENE**

| Substance   | Benzene  
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<tbody>
<tr>
<td>(Benzol)</td>
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<tr>
<td>CAS 71-43-2</td>
<td></td>
</tr>
<tr>
<td><strong>Formula</strong></td>
<td>$C_6H_6$</td>
</tr>
<tr>
<td><strong>Physical Properties</strong></td>
<td>Colorless liquid</td>
</tr>
<tr>
<td>bp 80.1 °C, mp 5.5 °C</td>
<td>Slightly soluble in water (0.18 g/100 mL)</td>
</tr>
<tr>
<td><strong>Odor</strong></td>
<td>&quot;Paint-thinner-like&quot; odor detectable at 12 ppm</td>
</tr>
<tr>
<td><strong>Vapor Density</strong></td>
<td>2.7 (air = 1.0)</td>
</tr>
<tr>
<td><strong>Vapor Pressure</strong></td>
<td>75 mmHg at 20 °C</td>
</tr>
<tr>
<td><strong>Flash Point</strong></td>
<td>-11.1 °C</td>
</tr>
<tr>
<td><strong>Autoignition Temperature</strong></td>
<td>560 °C</td>
</tr>
<tr>
<td><strong>Toxicity Data</strong></td>
<td></td>
</tr>
<tr>
<td>LD$_{50}$ oral (rat)</td>
<td>930 mg/kg</td>
</tr>
<tr>
<td>LC$_{50}$ inhal (rat)</td>
<td>10,000 ppm (7 h)</td>
</tr>
<tr>
<td>PEL (OSHA)</td>
<td>1 ppm (3.2 mg/m$^3$)</td>
</tr>
<tr>
<td>TLV-TWA (ACGIH)</td>
<td>10 ppm (32 mg/m$^3$)</td>
</tr>
<tr>
<td>STEL (ACGIH)</td>
<td>5 ppm (16 mg/m$^3$)</td>
</tr>
</tbody>
</table>
| **Major Hazards** | Highly flammable; chronic toxin affecting the blood-forming organs; OSHA "select carcinogen."
| **Toxicity** | The acute toxicity of benzene is low. Inhalation of benzene can cause dizziness, euphoria, giddiness, headache, nausea, drowsiness, and weakness. Benzene can cause moderate irritation to skin and severe irritation to eyes and mucous membranes. Benzene readily penetrates the skin to cause the same toxic effects as inhalation or ingestion. The chronic toxicity of benzene is significant. Exposure to benzene affects the blood and blood-forming organs such as the bone marrow, causing irreversible injury; blood disorders including anemia and leukemia may result. The symptoms of chronic benzene exposure may include fatigue, nervousness, irritability, blurred vision, and labored breathing. Benzene is regulated by OSHA as a carcinogen (Standard 1910.1028) and is listed in IARC Group 1 ("carcinogenic to humans"). This substance is classified as a "select carcinogen" under the criteria of the OSHA Laboratory Standard. |
Flammability and Explosibility

Benzene is a highly flammable liquid (NFPA rating = 3), and its vapors may travel a considerable distance to a source of ignition and "flash back." Vapor-air mixtures are explosive above the flash point. Carbon dioxide and dry chemical extinguishers should be used to fight benzene fires.

Reactivity and Incompatibility

Fire and explosion hazard with strong oxidizers such as chlorine, oxygen, and bromine (in the presence of certain catalysts such as iron) and with strong acids.

Accidents

In the event of skin contact, immediately wash with soap and water and remove contaminated clothing. In case of eye contact, promptly wash with copious amounts of water for 15 min (lifting upper and lower lids occasionally) and obtain medical attention. If benzene is ingested, obtain medical attention immediately. If large amounts of this compound are inhaled, move the person to fresh air and seek medical attention at once.

In the event of a spill, remove all ignition sources, soak up the benzene with a spill pillow or absorbent material, place in an appropriate container, and dispose of properly. Respiratory protection should be employed during spill cleanup.
Documentation of Training

(signature of all users is required)

- Prior to conducting any work with benzene, you must have received training specific to the hazards involved in working with this substance.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.

I have read and understand the content of this SOP, and have received any additional specific training that I deem necessary:

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SOP: Use of Chloroform

Date of last revision to SOP: Aug. 2014 – Kai Ewert

PI approval of SOP:

_________________________ (C. R. Safinya) ______________ Date

Scope of SOP

Use of chloroform (aka trichloromethane, TCM, CHCl₃) in the preparation of lipid and liposome solutions

Compound information

See the appended LCSS for more information.

Approval and Training Required

Before using chloroform, users must read the corresponding LCSS which is appended to this SOP.
For graduate student, postdocs and visiting researchers, specific approval is not required before performing this type of work. Undergraduate students and interns should be supervised when performing this work until they have demonstrated proficiency in safely handling hazardous solvents.

Chemical Hazard

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Hazard Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloroform</td>
<td>Toxic (see LCSS for details)</td>
</tr>
</tbody>
</table>

General precautions

Avoid contact with skin, eyes and clothing. Avoid inhalation of vapor or mist. Wash hands before breaks and immediately after handling chloroform.
Personal Protective Equipment

Users handling chloroform must employ the following personal protective measures:

- **Protective eyewear**
  ANSI-approved, tight-fitting safety glasses/goggles must be worn at all times. For procedures with splash potential, a face shield (available in the lab on the side of the single hood in room 1024) should be used.

- **Lab coat etc.**
  Use of a flame-resistant (“blue”) lab coat is preferred. Long pants or equivalent as well as closed-toe shoes are mandatory.

- **Lab gloves**
  It is important to note that the standard disposable exam gloves provided in the lab (latex or nitrile) do not form an appreciable barrier to chloroform. Even doubling up of these gloves will only provide protection for less than a second, but probably enough to reduce skin exposure if the gloves are removed immediately after exposure. While up to user discretion, the use of thicker and more resistant gloves may not reduce the overall risk of exposure due to the concomitant reduction in dexterity.

Engineering/Ventilation Controls

Chloroform and solvent mixtures containing chloroform must be handled in a fume hood. Use on the open bench is prohibited.

When solutions containing chloroform are removed from the fume hood, containers must be sealed. The use of chloroform on an open lab bench, in open containers, will likely result in worker exposures above the Cal-OSHA legal/safe limits for chloroform.

Special Chemical Handling, Storage, Cleanup and Disposal Requirements

- **Storage:**
  Chloroform must be stored in completely-sealed containers in one of the chemical storage cabinets underneath the fume hoods that are designated for solvent storage, away from strong bases in particular. For further information on incompatibilities, see the LCSS below.

- **Spills/Cleanup:**
  Spills of chloroform must be cleaned up as rapidly and completely as possible. Assess the extent of danger. Help contaminated or injured persons. Evacuate the spill area. Avoid breathing vapors. If possible, confine the spill to a small area.
using a spill kit or absorbent material. Keep others from entering contaminated area (e.g., use caution tape, barriers, etc.).

Place leaking containers in a fume hood. If it can be done safely, clean up small spills with absorbent material (e.g. paper towels), collect all contaminated materials (including gloves) in a tight-closing container, and arrange pickup with EH&S. Make sure to wear “Barrier” type gloves if cleaning up a chloroform spill. A small stock of “Barrier” type gloves is usually at hand in the cabinet in room 1032; these gloves are also available from the Physics storeroom. Respiratory protection may be necessary in the event of a large spill or in a confined area. Thus, for larger spills that can not be safely and completely handled by lab personnel, e.g. if a high hazard of exposure to fumes is present, leave the area and contact EH&S at x3194. Follow the procedures for emergencies outlined in the beginning of the CHP and in the SOP for chemical spills.

- First Aid:

  Call 9-911 (from campus phones, else 911) for immediate medical attention.

  **If inhaled**
  Move person into fresh air. If not breathing, give artificial respiration and call emergency services. Seek medical attention if needed.

  **In case of skin contact**
  Take off contaminated gloves, clothing, and/or shoes immediately. Wash the affected area with soap and copious amounts of water. Use the lab emergency shower/eyewash or a faucet as appropriate. Consult a physician.

  **In case of eye contact**
  Check for and remove any contact lenses. Rinse thoroughly with plenty of water for at least 15 minutes (lifting upper and lower lids occasionally). Use the lab emergency shower/eyewash or a faucet as appropriate. Consult a physician.

  **If swallowed**
  Never give anything by mouth to an unconscious person. Rinse mouth with water. Get medical attention immediately.

- Disposal:

  All chloroform wastes must be disposed of through EH&S like other chemical waste. Chloroform and chloroform-containing solutions should be disposed of by adding them to the “HALOGENATED SOLVENTS” collection bottle and entering the amount added on the list provided. Chloroform must not be allowed to enter the sewer system or trash or be left to freely evaporate.

Additional Information

For additional information on chloroform and its hazards, see its LCSS (appended to this SOP) and the EH&S fact sheet on chlorinated solvents in Appendix A. The fact sheet is also available on the web at

LCSS for CHLOROFORM

Substance

Chloroform  
(Trichloromethane)  
CAS 67-66-3

Formula

CHCl₃

Physical Properties

Colorless liquid  
bp 61 °C, mp -63.5 °C  
Slightly soluble in water (0.8 g/100 mL)

Odor

Ethereal, sweet odor detectable at 133 to 276 ppm (mean = 192 ppm)

Vapor Density

4.1 (air = 1.0)

Vapor Pressure

160 mmHg at 20 °C

Flash Point

Noncombustible

Toxicity Data

LD₉₀ oral (rat) 908 mg/kg  
LD₅₀ skin (rabbit) >20 g/kg  
LC₅₀ inhial (rat) 9937 ppm (47,702 mg/m³; 4 h)  
PEL (OSHA) 50 ppm (240 mg/m³; ceiling)  
TLV-TWA (ACGIH) 10 ppm (48 mg/m³)
Major Hazards

Low acute toxicity; skin and eye irritant.

Toxicity

The acute toxicity of chloroform is low by all routes of exposure. Inhalation can cause dizziness, headache, drowsiness, and nausea, and at higher concentrations, disorientation, delirium, and unconsciousness. Inhalation of high concentrations may also cause liver and kidney damage. Exposure to 25,000 ppm for 5 min can be fatal to humans. Ingestion of chloroform can cause severe burning of the mouth and throat, chest pain, and vomiting. Chloroform is irritating to the skin and eyes, and liquid splashed in the eyes can cause burning pain and reversible corneal injury. Olfactory fatigue occurs on exposure to chloroform vapor, and it is not regarded as a substance with adequate warning properties.

Chloroform shows carcinogenic effects in animal studies and is listed by IARC in Group 2B ("possible human carcinogen"). It is not classified as a "select carcinogen" according to the criteria of the OSHA Laboratory Standard. Prolonged or repeated exposure to this substance may result in liver and kidney injury. There is some evidence from animal studies that chloroform is a developmental and reproductive toxin.

Flammability and Explosibility

Chloroform is noncombustible. Exposure to fire or high temperatures may lead to formation of phosgene, a highly toxic gas.

Reactivity and Incompatibility

Chloroform reacts violently with alkali metals such as sodium and potassium, with a mixture of acetone and base, and with a number of strong bases such as potassium and sodium hydroxide, potassium t-butoxide, sodium methoxide, and sodium hydride. Chloroform reacts explosively with fluorine and dinitrogen tetroxide.

Storage and Handling

Chloroform should be handled in the laboratory using the "basic prudent practices" described in Chapter 5.C. In the presence of light, chloroform undergoes autoxidation to generate phosgene; this can be minimized by storing this substance in the dark under nitrogen. Commercial samples of chloroform frequently contain 0.5 to 1% ethanol as a stabilizer.

Accidents

In the event of skin contact, immediately wash with soap and water and remove contaminated clothing. In case of eye contact, promptly wash with copious amounts of water for 15 min (lifting upper and lower lids occasionally) and obtain medical attention.
If chloroform is ingested, obtain medical attention immediately. If large amounts of this compound are inhaled, move the person to fresh air and seek medical attention at once.

In the event of a spill, soak up chloroform with a spill pillow or absorbent material, place in an appropriate container, and dispose of properly. Respiratory protection may be necessary in the event of a large spill or release in a confined area.

The information in this LCSS has been compiled by a committee of the National Research Council from literature sources and Material Safety Data Sheets and is believed to be accurate as of July 1994. This summary is intended for use by trained laboratory personnel in conjunction with the NRC report Prudent Practices in the Laboratory: Handling and Disposal of Chemicals. This LCSS presents a concise summary of safety information that should be adequate for most laboratory uses of the title substance, but in some cases it may be advisable to consult more comprehensive references. This information should not be used as a guide to the nonlaboratory use of this chemical.
**Documentation of Training**

(signature of all users is required)

- Prior to conducting any work with chloroform, you must have received training specific to the hazards involved in working with this substance.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.

I have read and understand the content of this SOP, and have received any additional specific training that I deem necessary:

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SOP: Use of Dichloromethane

NOTE: Dichloromethane (aka methylene chloride, CH₂Cl₂, DCM) is classified as a Particularly Hazardous Substance (PHS) per Cal-OSHA, since it is listed as a “Select” Carcinogen.

Date of last revision to SOP: Aug. 2014 – Kai Ewert

PI approval of SOP:

_________________________ (C. R. Safinya) ______________ Date

Scope of SOP

Use of dichloromethane in chemistry procedures in the lab

Compound information

Dichloromethane (aka methylene chloride, CH₂Cl₂, DCM) is an OHSA regulated carcinogen. It is a colorless organic solvent.

Dichloromethane is very hazardous in case of eye contact (irritant), of ingestion, and of inhalation. Inflammation of the eye is characterized by redness, watering, and itching. Eye contact may cause temporal eye damage. 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.

Dichloromethane is hazardous in case of skin contact (irritant, permeator). Chronic exposure to dichloromethane can cause headache, mental confusion, depression, liver effects, kidney effects, bronchitis, loss of appetite, nausea, lack of balance, and visual disturbances. Dichloromethane can cause dermatitis upon prolonged skin contact. Dichloromethane may cause cancer in humans.

Approval Required

Anyone working for the first time with dichloromethane in this laboratory must consult with Dr. Kai Ewert. Users must study the relevant safety information and be aware of the appropriate waste disposal method (via halogenated solvent waste).
General precautions

Avoid contact with skin, eyes and clothing. Avoid inhalation of vapor or mist. Wash hands before breaks and immediately after handling dichloromethane.

Personal Protective Equipment

Users of dichloromethane shall employ the following:

- **Protective eyewear**
  ANSI-approved, tight-fitting safety glasses/goggles must be worn at all times. For procedures with splash potential, a face shield (available in the lab on the side of the single hood in room 1024) should be used.

- **Lab coat etc.**
  Use of a flame-resistant (“blue”) lab coat is mandatory, as are long pants and closed-toe shoes.

- **Lab gloves**
  Standard latex or nitrile gloves do not provide adequate protection from dichloromethane spills. As per UCSB EH&S, only “Silver Shield”, Viton, Polyvinyl Alcohol, or “Barrier” gloves offer protection. Note that Polyvinyl Alcohol is a water soluble polymer, so use caution when also handling aqueous solutions. A small stock of “Barrier” type gloves is usually at hand in the cabinet in room 1032; these gloves are also available from the Physics storeroom.

Engineering/Ventilation Controls

Dichloromethane must be handled in a **fume hood**. Use on the open bench is prohibited.

When outside of the fume hood, containers must be sealed. The use of dichloromethane on an open lab bench, in open containers, will likely result in worker exposures above the Cal-OSHA legal/safe limits for dichloromethane.

Handling, Storage, Cleanup, First Aid, and Disposal Requirements

- **Handling:**
  Work with dichloromethane must be performed in the laboratory fume hoods.

- **Storage:**
  Dichloromethane must be stored in completely sealed containers in one of the storage cabinets underneath the fume hoods.
• **Spills/Cleanup:**
Spills of dichloromethane must be cleaned up as rapidly and completely as possible. Assess the extent of danger. Help contaminated or injured persons. Evacuate the spill area. Avoid breathing vapors. If possible, confine the spill to a small area using a spill kit or absorbent material. Keep others from entering contaminated area (e.g., use caution tape, barriers, etc.). Place leaking containers in a fume hood. If it can be done safely, clean up small spills with absorbent material (e.g. paper towels) and collect all contaminated materials (including gloves) in a tight-closing container. Make sure to wear “Barrier” type gloves if cleaning up a dichloromethane spill. A small stock of “Barrier” type gloves is usually at hand in the cabinet in room 1032; these gloves are also available from the Physics storeroom. For larger spills that can not be safely and completely handled by lab personnel, leave the area and contact EH&S at x3194. Follow the procedures for emergencies outlined in the beginning of the CHP and in the SOP for chemical spills.

• **First Aid:**
Call 9-911 (from campus phones, else 911) for immediate medical attention.

  **If inhaled**
Move person into fresh air. If not breathing, give artificial respiration and call emergency services. Seek medical attention if needed.

  **In case of skin contact**
Take off contaminated clothing and shoes immediately. Minor skin contact requires washing with soap and water. Soaking or flushing contaminated areas of the skin with water for periods up to 15 minutes is required if a large area comes into contact with dichloromethane, or if prolonged contact occurs. Use the lab emergency shower/eyewash or a faucet as appropriate. Consult a physician.

  **In case of eye contact**
Check for and remove any contact lenses. Rinse thoroughly with plenty of water for at least 15 minutes (lifting upper and lower lids occasionally). Use the lab emergency shower/eyewash or a faucet as appropriate. Consult a physician. Continue rinsing eyes during transport to hospital.

  **If swallowed**
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Get medical attention immediately.

• **Disposal:**
All dichloromethane wastes must be disposed of through EH&S as halogenated solvent waste. No dichloromethane must go into the sewer system, trash or be allowed to freely evaporate.
Additional Information

For additional information on dichloromethane and its hazards, see the LCSS for dichloromethane (appended to this SOP) and the EH&S fact sheets in Appendix A. The fact sheet is also available on the web at


LCSS for DICHLOROMETHANE

<table>
<thead>
<tr>
<th>Substance</th>
<th>Dichloromethane (Methylene chloride; aerothene MM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAS</td>
<td>75-09-2</td>
</tr>
<tr>
<td>Formula</td>
<td>CH₂Cl₂</td>
</tr>
<tr>
<td>Physical Properties</td>
<td>Colorless liquid</td>
</tr>
<tr>
<td></td>
<td>bp 40 °C, mp -97 °C</td>
</tr>
<tr>
<td></td>
<td>Slightly soluble in water (1.32 g/100 mL)</td>
</tr>
<tr>
<td>Odor</td>
<td>Odor threshold 160 to 230 ppm</td>
</tr>
<tr>
<td>Vapor Density</td>
<td>2.93 (air = 1.0)</td>
</tr>
<tr>
<td>Vapor Pressure</td>
<td>440 mmHg at 25 °C</td>
</tr>
<tr>
<td>Flash Point</td>
<td>Noncombustible</td>
</tr>
<tr>
<td>Autoignition Temperature</td>
<td>556 °C</td>
</tr>
<tr>
<td>Toxicity Data</td>
<td></td>
</tr>
<tr>
<td>LD₅₀ oral (rat)</td>
<td>1600 mg/kg</td>
</tr>
<tr>
<td>LC₅₀ inhal (rat)</td>
<td>88,000 mg/m³; 30 min</td>
</tr>
<tr>
<td>PEL (OSHA)</td>
<td>500 ppm (8 h)</td>
</tr>
<tr>
<td>TLV-TWA (ACGIH)</td>
<td>50 ppm</td>
</tr>
<tr>
<td>Major Hazards</td>
<td>Low acute toxicity; skin and eye irritant.</td>
</tr>
<tr>
<td>Toxicity</td>
<td>Dichloromethane is classified as only slightly toxic by the oral and inhalation routes. Exposure to high concentrations of dichloromethane vapor (&gt;500 ppm for 8 h) can lead to lightheadedness, fatigue, weakness, and nausea. Contact of the compound with the eyes causes painful irritation and can lead to conjunctivitis and corneal injury if not promptly removed by washing. Dichloromethane is a mild skin irritant, and upon prolonged contact (e.g., under the cover of clothing or shoes) can cause burns after 30 to 60 min exposure. Dichloromethane is not teratogenic at levels up to 4500 ppm or embryotoxic in rats and mice at levels up to 1250 ppm.</td>
</tr>
<tr>
<td>Flammability and Explosibility</td>
<td>Noncombustible. Dichloromethane vapor concentrated in a confined or poorly ventilated area can be ignited with a high-energy spark,</td>
</tr>
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</table>
Reactivity and Incompatibility

Reacts violently with alkali metals, aluminum, magnesium powder, potassium t-butoxide, nitrogen tetroxide, and strong oxidizing agents.

Accidents

In the event of skin contact, immediately wash with soap and water and remove contaminated clothing. In case of eye contact, promptly wash with copious amounts of water for 15 min (lifting upper and lower lids occasionally) and obtain medical attention. If dichloromethane is ingested, obtain medical attention immediately. If large amounts of this compound are inhaled, move the person to fresh air and seek medical attention at once.

In the event of a spill, soak up dichloromethane with a spill pillow or absorbent material, place in an appropriate container, and dispose of properly. Respiratory protection may be necessary in the event of a large spill or release in a confined area.
Documentation of Training

(signature of all users is required)

- Prior to conducting any work with dichloromethane, you must have received training specific to the hazards involved in working with this substance.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.

I have read and understand the content of this SOP, and have received any additional specific training that I deem necessary:

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SOP: Use of Formaldehyde and Formalin
(aqueous formaldehyde solution)

NOTE: Formaldehyde is classified as a Particularly Hazardous Substance (PHS) per Cal-OSHA, since it is listed as a “Select” Carcinogen.

Date of last revision to SOP: Aug. 2014 – Kai Ewert

NOTE: For brevity, in the following “formaldehyde” refers to formaldehyde as well as its aqueous solutions (“formalin”), unless otherwise specified.

PI approval of SOP:

_________________________ (C. R. Safinya) ______________ Date

Compound information

Formaldehyde an OHSA regulated carcinogen. Formaldehyde is a flammable gas at room temperature that is mainly used in laboratories and sold as a solution in water or methanol. It is commonly used as a fixative and as a nucleic acid denaturant. The odor threshold of formaldehyde is reported to be as low as 0.1 ppm. The OSHA Permissible Exposure Limit is 0.75 ppm in an eight hour time weighted average.

Formaldehyde is hazardous in case of eye contact (irritant) and of ingestion; slightly hazardous in case of skin contact (irritant, sensitizer, permeator); Non-corrosive for skin, eyes, or lungs. Chronic skin contact is slightly hazardous (sensitizer). Severe over-exposure can result in death.

Formaldehyde is mutagenic for mammalian somatic cells and for bacteria and/or yeast. It is classified as a possible teratogen for humans and as a reproductive system toxin. Formaldehyde may be toxic to kidneys, liver, central nervous system (CNS). Repeated or prolonged exposure can produce target organs damage. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Approval Required

Anyone working for the first time with formaldehyde in this laboratory needs to consult with Dr. Kai Ewert. Users must study the relevant safety information and ensure an appropriate waste disposal method is in place before commencing work.
General precautions

Avoid contact with skin, eyes and clothing. Avoid inhalation of vapor or mist. Wash hands before breaks and immediately after handling formaldehyde.

Personal Protective Equipment

Users of formaldehyde shall employ the following:

- **Protective eyewear**
  ANSI-approved, tight-fitting safety glasses/goggles must be worn at all times. Formaldehyde poses a severe threat of injury to the eye. Accordingly, for procedures with splash potential, a face shield (available in the lab on the side of the single hood in room 1024) should be used.

- **Lab coat etc.**
  Use of an appropriate lab coat for the work and areas you work in (as per LHAT) is mandatory, as are long pants or equivalent and closed-toe shoes.

- **Lab gloves**
  Gloves must be worn when handling formaldehyde. Nitrile and neoprene gloves are the only acceptable choices as per EH&S.

Engineering/Ventilation Controls

Formaldehyde must be handled in a **fume hood or the biosafety cabinet**. Use on the open bench is prohibited except when it is impractical (i.e. equipment will not fit in hood), in which case you need to check with Kai Ewert before performing the work.

When used outside of the above containment devices, containers must be sealed. The use of formaldehyde on an open lab bench, in open containers, will likely result in worker exposures above the Cal-OSHA legal/safe limits for formaldehyde.

Handling, Storage, Cleanup, First Aid, and Disposal Requirements

- **Handling:**
  Work with formaldehyde must be performed in the laboratory fume hoods or the biosafety cabinet, or in a closed container.

- **Storage:**
  Formaldehyde must be stored in completely-sealed containers in one of the chemical storage cabinets underneath the fume hoods.
• **Spills/Cleanup:**

Spills of formaldehyde must be cleaned up as quickly and completely as possible. Assess the extent of danger. Help contaminated or injured persons. Evacuate the spill area. Avoid breathing vapors. If possible, confine the spill to a small area using a spill kit or absorbent material. Keep others from entering contaminated area (e.g., use caution tape, barriers, etc.). Place leaking containers in a fume hood. If it can be done safely, clean up small spills with absorbent material (e.g. paper towels) and collect all contaminated materials (including gloves) in a tight-closing container. Wear doubled nitrile gloves. For larger spills that can not be safely and completely handled by lab personnel, leave the area and contact EH&S at x3194. Follow the procedures for emergencies outlined in the beginning of the CHP and in the SOP for chemical spills.

• **First Aid:**

Call 9-911 (from campus phones, else 911) for immediate medical attention.

**If inhaled**
Move person into fresh air. If not breathing, give artificial respiration and call emergency services. If breathing is difficult, give oxygen. Seek medical attention.

**In case of skin contact**
Take off contaminated clothing and shoes immediately. Flush contaminated areas of the skin with plenty of water for at least 15 minutes. Use the lab emergency shower/eyewash or a faucet as appropriate. Take the victim immediately to a hospital.

**In case of eye contact**
Check for and remove any contact lenses. Rinse thoroughly with plenty of water for at least 15 minutes (lifting upper and lower lids occasionally). Use the lab emergency shower/eyewash or a faucet as appropriate. Consult a physician. Continue rinsing eyes during transport to hospital.

**If swallowed**
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Get medical attention immediately. If the victim is conscious and alert, give milk, activated charcoal, or water.

• **Disposal:**

All formaldehyde wastes must be disposed of through EH&S like other chemical waste. No formaldehyde must go into the sewer system, trash or be allowed to freely evaporate. If no appropriate / designated collection bottle / procedure is in place, contact Kai Ewert.
Additional Information

For additional information on formaldehyde and its hazards, see the LCSS for formaldehyde (appended to this SOP) and the EH&S fact sheets in Appendix A. The fact sheet is also available on the web at


LCSS for FORMALDEHYDE

Substance

Formaldehyde
(Methanal; 37% aqueous solution (usually containing 10 to 15% methanol) is called formalin; solid polymer is called paraformaldehyde)
CAS 50-00-0

Formula

HCHO

Physical Properties

Clear, colorless liquid
Formaldehyde: bp -19 °C, mp -92 °C
Formalin: bp 96 °C, mp -15 °C
Miscible with water

Odor

Pungent odor detectable at 1 ppm

Vapor Density

~1 (air = 1.0)

Vapor Pressure

Formaldehyde: 10 mmHg at -88 °C
Formalin: 23 to 26 mmHg at 25 °C

Flash Point
50 °C for formalin containing 15% methanol

**Autoignition Temperature**

424 °C for formalin containing 15% methanol

**Toxicity Data**

- LD$_{50}$ oral (rat) 500 mg/kg
- LD$_{50}$ skin (rabbit) 270 mg/kg
- LC$_{50}$ inh (rat) 203 mg/m$^3$(2 h)
- PEL (OSHA) 1 ppm (1.5 mg/m$^3$)
- TLV-TWA (ACGIH) 0.3 ppm (ceiling)(0.37 mg/m$^3$)
- STEL (OSHA) 2 ppm (2.5 mg/m$^3$)

**Major Hazards**

Probable human carcinogen (OSHA "select carcinogen"); moderate acute toxicity; skin sensitizer.

**Toxicity**

Formaldehyde is moderately toxic by skin contact and inhalation. Exposure to formaldehyde gas can cause irritation of the eyes and respiratory tract, coughing, dry throat, tightening of the chest, headache, a sensation of pressure in the head, and palpitations of the heart. Exposure to 0.1 to 5 ppm causes irritation of the eyes, nose, and throat; above 10 ppm severe lacrimation occurs, burning in the nose and throat is experienced, and breathing becomes difficult. Acute exposure to concentrations above 25 ppm can cause serious injury, including fatal pulmonary edema. Formaldehyde has low acute toxicity via the oral route. Ingestion can cause irritation of the mouth, throat, and stomach, nausea, vomiting, convulsions, and coma. An oral dose of 30 to 100 mL of 37% formalin can be fatal in humans. Formalin solutions can cause severe eye burns and loss of vision. Eye contact may lead to delayed effects that are not appreciably eased by eye washing.

Formaldehyde is regulated by OSHA as a carcinogen (Standard 1910.1048) and is listed in IARC Group 2A ("probable human carcinogen"). This substance is classified as a "select carcinogen" under the criteria of the OSHA Laboratory Standard. Prolonged or repeated exposure to formaldehyde can cause dermatitis and sensitization of the skin and respiratory tract. Following skin contact, a symptom-free period may occur in sensitized individuals. Subsequent exposures can then lead to itching, redness, and the formation of blisters.

**Flammability and Explosibility**

Formaldehyde gas is extremely flammable; formalin solution is a combustible liquid (NFPA rating = 2 for 37% formaldehyde (15% methanol), NFPA rating = 4 for 37%
formaldehyde (methanol free)). Toxic vapors may be given off in a fire. Carbon dioxide or dry chemical extinguishers should be used to fight formaldehyde fires.

Reactivity and Incompatibility

Formaldehyde may react violently with strong oxidizing agents, ammonia and strong alkalis, isocyanates, peracids, anhydrides, and inorganic acids. Formaldehyde reacts with HCl to form the potent carcinogen, bis-chloromethyl ether.

Storage and Handling

[...] work with formaldehyde should be conducted in a fume hood to prevent exposure by inhalation, and splash goggles and impermeable gloves should be worn at all times to prevent eye and skin contact. Formaldehyde should be used only in areas free of ignition sources. Containers of formaldehyde should be stored in secondary containers in areas separate from oxidizers and bases.

Accidents

In the event of skin contact, immediately wash with soap and water and remove contaminated clothing. In case of eye contact, promptly wash with copious amounts of water for 15 min (lifting upper and lower lids occasionally) and obtain medical attention. If formaldehyde is ingested, obtain medical attention immediately. If large amounts of this compound are inhaled, move the person to fresh air and seek medical attention at once.

In the event of a spill, remove all ignition sources, soak up the formaldehyde with a spill pillow or absorbent material, place in an appropriate container, and dispose of properly. Respiratory protection may be necessary in the event of a large spill or release in a confined area.
Documentation of Training

(signature of all users is required)

- Prior to conducting any work with formaldehyde, you must have received training specific to the hazards involved in working with this substance.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.

I have read and understand the content of this SOP, and have received any additional specific training that I deem necessary:

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SOP: Use of Ethidium Bromide

Date of last revision to SOP: Aug. 2014 – Kai Ewert

PI approval of SOP:

_________________________ (C. R. Safinya) ______________ Date

Scope of SOP

Use of ethidium bromide for the detection and approximate quantification of nucleic acids by fluorescence

Compound information

Ethidium bromide (EtBr) is a mutagen. If not stored and handled properly, this can pose a serious threat to the health and safety of laboratory personnel, emergency responders and chemical waste handlers. Hence, it is important to follow safe protocols for handling and disposal.

EtBr can be absorbed through skin, and will stain it purple. EtBr is an irritant to the skin, eyes, mouth, and upper respiratory tract.

Ethidium Bromide is commonly used as a non-radioactive DNA stain to identify and visualize nucleic acid bands in electrophoresis and perform other methods of nucleic acid separation. Solutions of EtBr fluoresce readily with a reddish-brown color when exposed to ultraviolet (UV) light.

Approval and Training Required

Before using ethidium bromide, users must read the corresponding LCSS which is appended to this SOP.

For graduate student, postdocs and visiting researchers, specific approval is not required before performing this type of work. Undergraduate students and interns should be supervised when performing this work until they have demonstrated proficiency in safely handling the hazardous materials involved.

Chemical Hazard

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Hazard</th>
</tr>
</thead>
</table>

83 KE, Rev. 8/18/14
Ethidium Bromide

Highly mutagenic (see LCSS for details)

General precautions

Avoid contact with skin, eyes and clothing. Avoid inhalation of dust or mist/aerosols from solutions. Wash hands before breaks and immediately after handling ethidium bromide and its solutions.

Personal Protective Equipment

Users handling ethidium bromide must use the following personal protective equipment:

NOTE: Use UV light to check reusable protective equipment (e.g. safety glasses, lab coats) for contamination with ethidium bromide.

- **Protective eyewear**
  
  ANSI-approved, tight-fitting safety glasses/goggles must be worn at all times. For procedures with splash potential, a face shield (available in the lab on the side of the single hood in room 1024) should be used.

- **Lab coat etc.**
  
  Use a lab coat (appropriate for the lab and work being performed as per LHAT) is mandatory, as are long pants and closed-toe shoes.

- **Lab gloves**
  
  To protect the skin from exposure to ethidium bromide powder and aqueous solutions, nitrile or latex disposable exam gloves must be worn. Inspect gloves prior to use. Do not reuse gloves used for working with ethidium bromide.

Users handling ethidium bromide are encouraged to employ the following personal protective measures:

Engineering/Ventilation Controls

While the use of a fume hood is not required for work involving aqueous solutions of ethidium bromide, care must be taken to minimize dispersion of the powder form of ethidium bromide into the lab air.

Means should be taken to facilitate the cleanup of potential spills. This includes covering of lab benches with adsorbent but impermeable covering (available in the lab) and / or handling of ethidium bromide and its solutions in a fume hood.
Special Chemical Handling, Storage, Cleanup and Disposal Requirements

- **Storage:**
  
  There are no special storage requirements for ethidium bromide. However, any containers with ethidium bromide must be clearly labeled as “highly toxic”.

- **First Aid:**

  Call 9-911 (from campus phones, else 911) for immediate medical attention.

  **If inhaled**
  
  If EtBr dust is inhaled, move the victim to a source of fresh air. Seek medical attention immediately.

  **In case of skin contact**
  
  Take off contaminated clothing and shoes immediately. Wash the affected area with soap and copious amounts of water for 15 minutes. Use the lab emergency shower/eyewash or a faucet as appropriate. Consult a physician.

  **In case of eye contact**
  
  Check for and remove any contact lenses. Rinse thoroughly with plenty of water for at least 15 minutes (lifting upper and lower lids occasionally). Use the lab emergency shower/eyewash or a faucet as appropriate.

  **If swallowed**
  
  In the case of EtBr ingestion, obtain medical attention immediately.

- **Spills/Cleanup:**

  Spills of ethidium bromide must be cleaned up as rapidly and completely as possible.

  Assess the extent of danger. Help contaminated or injured persons. Evacuate the spill area. Avoid breathing vapors. If possible, confine the spill to a small area using a spill kit or absorbent material. Keep others from entering contaminated area (e.g., use caution tape, barriers, etc.).

  Avoid raising dust when cleaning up a powder spill, e.g. by covering the spill with a layer of moistened paper towels. If it can be done safely, clean up small spills (after putting on two layers of disposable nitrile gloves) with absorbent material (e.g. paper towels). Collect all contaminated materials (including gloves) in a tight-closing container, and arrange pickup with EH&S. Check for successful decontamination with UV light.

  For larger spills that can not be safely and completely handled by lab personnel, leave the area and contact EH&S at x3194. Follow the procedures for emergencies outlined in the beginning of the CHP and in the SOP for chemical spills.

- **Disposal:**

  All ethidium bromide wastes must be disposed of through EH&S like other chemical waste. Ethidium bromide wastes require their own, separate collection
container. If no such container is available in the lab’s chemical waste storage area, start a new container (contact Kai Ewert with questions on how to do this).

Additional Information

For additional information on ethidium bromide and its hazards, see its LCSS (appended to this SOP) and the EH&S fact sheet on ethidium bromide safety in Appendix A. The fact sheet is also available on the web at

http://ehs.ucsb.edu/units/labsfty/labrsc/factsheets/EtBr.pdf

LCSS for ETHIDIUM BROMIDE

Substance

Ethidium bromide
(Dromilac, homidium bromide)
CAS 1239-45-8

Formula

C_{21}H_{20}BrN_{3}

Physical Properties

Dark red crystals
mp 260 to 262 °C
Soluble in water (5 g/100 mL)

Odor

Odorless solid

Major Hazards

Potent mutagen

Toxicity

Acute toxic effects from exposure to ethidium bromide have not been thoroughly investigated. Ethidium bromide is irritating to the eyes, skin, mucous membranes, and upper respiratory tract.
Although there is no evidence for the carcinogenicity or teratogenicity of this substance in humans, ethidium bromide is strongly mutagenic and therefore should be regarded as a possible carcinogen and reproductive toxin.

**Flammability and Explosibility**

Ethidium bromide does not pose a flammability hazard (NFPA rating = 1).

**Reactivity and Incompatibility**

No incompatibilities are known.

**Storage and Handling**

Ethidium bromide should be handled in the laboratory using the "basic prudent practices" described in Chapter 5.C. Because of its mutagenicity, stock solutions of this compound should be prepared in a fume hood, and protective gloves should be worn at all times while handling this substance. Operations capable of generating ethidium bromide dust or aerosols of ethidium bromide solutions should be conducted in a fume hood to prevent exposure by inhalation.

**Accidents**

In the event of skin contact, immediately wash with soap and water and remove contaminated clothing. In case of eye contact, promptly wash with copious amounts of water for 15 min (lifting upper and lower lids occasionally) and obtain medical attention. If ethidium bromide is ingested, obtain medical attention immediately.

In the event of a spill, mix ethidium bromide with an absorbent material (avoid raising dust), place in an appropriate container, and dispose of properly. Soak up aqueous solutions with a spill pillow or absorbent material.

**Disposal**

Excess ethidium bromide and waste material containing this substance should be placed in an appropriate container, clearly labeled, and handled according to your institution's waste disposal guidelines.

The information in this LCSS has been compiled by a committee of the National Research Council from literature sources and Material Safety Data Sheets and is believed to be accurate as of July 1994. This summary is intended for use by trained laboratory personnel in conjunction with the NRC report “Prudent Practices in the Laboratory: Handling and Disposal of Chemicals” (http://www.nap.edu/catalog.php?record_id=12654). This LCSS presents a concise summary of safety information that should be adequate for most laboratory uses of the title substance, but in some cases it may be advisable to consult more comprehensive references. This information should not be used as a guide to the nonlaboratory use of this chemical.
Documentation of Training

(signature of all users is required)

- Prior to conducting any work with ethidium bromide, you must have received training specific to the hazards involved in working with this substance.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.

I have read and understand the content of this SOP, and have received any additional specific training that I deem necessary:

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SOP: Use of “Particularly Hazardous Substances”

Date of last revision to SOP: Aug. 2014 (Kai Ewert)

Prepared from a template provided by UCSB EH&S.

PI approval of SOP:

_________________________ (C. R. Safinya) ______________ Date

Definitions / Compound Lists

Per Cal-OSHA, Particularly Hazardous Substances (PHS) are “Select” Carcinogens, Reproductive Toxins and Highly Acute Toxins. Links to definitions and lists of these materials are below.

“Select” Carcinogens
(see list at http://ehs.ucsb.edu/units/labsfty/labsc/chemistry/lschphazsubstance.htm)
“Select” Carcinogens include carcinogens which are further regulated by Cal-OSHA, e.g. formaldehyde, acrylonitrile, dichloromethane, benzene, (see the corresponding SOPs), chromium VI compounds (e.g. sodium chromate), cadmium compounds, and arsenic compounds (e.g. cacodylic acid, sodium cacodylate). Laboratory fact sheets on these materials may be available from the EH&S website. A list of laboratory safety fact sheets is available at
http://ehs.ucsb.edu/units/labsfty/labsc/factsheets/lsfac sheets.htm

Reproductive Toxins
(see list at http://ehs.ucsb.edu/units/labsfty/labsc/chemistry/lschphazsubstance.htm)

Highly acute toxins
(see list at http://ehs.ucsb.edu/units/labsfty/labsc/chemistry/lschphazsubstance.htm)

Approval Required

Discuss materials, procedures, and protective measures with Kai Ewert before beginning any work with PHS.

General precautions

Avoid contact with skin, eyes and clothing. Avoid inhalation of vapor, mist or aerosols. Wash hands before breaks and immediately after handling.
Personal Protective Equipment

Use of PHS must employ the following:

- **Protective eyewear**
  ANSI-approved, tight-fitting safety glasses/goggles must be worn at all times. When handling corrosives in large quantities (e.g. > 1 gallon) or when performing procedures with a high potential for splashes, a face shield (available in the lab on the side of the single hood in room 1024) should be used.

- **Lab coat etc.**
  You must use a fire-resistant (“blue”) lab coat if working in the main MRL labs (rooms 1012, 1024, 1032). You must also wear long pants or equivalent and closed-toe shoes.

- **Lab gloves**
  If you need gloves to prevent skin exposure, make sure to check that the gloves you plan to use are resistant (impermeable) to the material in question. Note that some common carcinogens such as dichloromethane and benzene readily permeate common lab gloves such as latex, nitrile and neoprene. Here are glove guidelines for “select” carcinogens that are stored in the lab but not currently used:
  - for protection from chromium VI compounds – use butyl or viton or nitrile gloves
  - hand protection from cadmium and arsenic can be achieved by wearing gloves appropriate for the solvent in which these chemicals are dissolved. In the typical case of the solvent being water, nitrile or latex gloves will suffice

  A glove reference chart can be found at [http://ehs.ucsb.edu/units/labsfly/labrsc/lsglove.htm](http://ehs.ucsb.edu/units/labsfly/labrsc/lsglove.htm)

Engineering/Ventilation Controls

Volatile, or dust/aerosol-producing PHS must be used in a **fume hood or the biosafety cabinet**. Use on the open bench is prohibited.

When used outside of the above containment devices, containers must be sealed. Note that the use of volatile PHS such as formalin, acrylonitrile, dichloromethane and benzene on an open lab bench, in open containers, would probably result in worker exposures above the Cal-OSHA legal/safe limits for such materials.

Special Chemical Handling, Storage, Cleanup or Disposal Requirements

Under the CHP law, an area must be designated for working with PHS. The designated area may be the entire laboratory, an area of the lab, or a device such as a laboratory
At UCSB, the designated PHS work area is the entire laboratory, unless the supervisor specifies otherwise herein; either in general, or for a specific material or operation.

PHS must be stored in completely-sealed containers. Although hood storage of chemicals is generally discouraged, volatile PHS can be stored in a fume hood if deemed necessary.

Spills of PHS must be completely cleaned up.
Assess the extent of danger. Help contaminated or injured persons. Evacuate the spill area. Avoid breathing vapors. If possible, confine the spill to a small area using a spill kit or absorbent material. Keep others from entering contaminated area (e.g., use caution tape, barriers, etc.).
Spills that can not be safely and completely handled by lab personnel must be reported to EH&S at x3194 for assistance. Follow the procedures for emergencies outlined in the beginning of the CHP and in the SOP for chemical spills.

Like all chemical wastes, disposal of PHS must be done through EH&S. No PHS, or other chemical wastes can go into the sewer system, trash or be allowed to freely evaporate. If no appropriate / designated collection bottle / procedure is in place, contact Kai Ewert.
SOP Template: High Hazard Lab Operations

This blank template is for developing SOPs for any “high-hazard” chemical operations not covered by the template for Use of PHS. The development of lab-specific SOPs for high hazard operations is the responsibility and determination of the supervisor. OSHA does not have specific requirements for SOP content. EH&S recommends that the following elements be considered in SOP development, but supervisors should expand on as appropriate.

Date of last revision to SOP:

Scope of SOP

SOPs can be based on a specific chemical; a class of chemicals; a specific or set of lab procedures; a specific piece of equipment, etc.

PI approval of SOP:

_________________________ (C. R. Safinya) ______________ Date

Approval Required

Discuss any circumstances under which this operation requires prior approval. E.g. “undergraduates can not do this operation without my specific consent”.

Hazardous Chemicals

List chemicals and their hazard class, e.g., “carcinogenic, highly toxic, flammable, teratogen, corrosive, etc.” Better yet, print and attach LCSS or SDS (see above for sources)

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Hazard Class</th>
</tr>
</thead>
</table>


Personal Protective Equipment

List specific personal protective equipment needed, e.g., gloves, coats, eyewear. If a respirator is needed, contact EH&S (x8787).
EH&S webpage with Glove Reference Chart to Identify the Proper Gloves:
http://ehs.ucsb.edu/units/labsfty/labrsc/lsglove.htm

Engineering/Ventilation Controls

Describe required engineering controls. Examples: fume hoods glove boxes, biosafety cabinets, pressure relief valves, leak detection systems, auto-shut off valves, etc.

Any Special Chemical Handling, Storage, Cleanup or Disposal Requirements

Other
**Documentation of Training**

(signature of all users is required)

I have read and understand the content of this SOP, and have received any additional specific training that I deem necessary:

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SOP: Chemical Storage

Date of last revision to SOP: Aug. 2014 – Kai Ewert

PI approval of SOP:

_________________________ (C. R. Safinya) ______________ Date

Basic Instructions

Proper chemical storage is essential in assuring a safe laboratory environment. Incompatible materials must always be separated in storage. Chemicals must be stored in a way that does not create additional hazards in the event of an earthquake.

Chemicals should be stored safely when not in actual use, so as not to create a tripping / spill / breakage hazard. It is the responsibility of each person who uses chemicals to ensure that they are put away safely when they are done using the chemicals each day.

Fume hoods are not storage areas and should not be used as such.

Any volatile solvents, chemicals or explosive gases requiring refrigeration in open or sealed containers must be stored in the designated “Flammables” fridge/freezer in room 1012.

Vented chemical storage cabinets are available under most fume hoods in room 1012 and 1024. Use these cabinets for storage of all hazardous chemicals which do not require refrigeration, and preferably for any chemical storage.

We have a large inventory of chemicals. To avoid buying chemicals that we already have in the lab, look in the chemical storage areas and check with Kai before ordering a new chemical. Some chemicals are also available via the surplus chemical program from other groups at UCSB who no longer need them (see the program’s website at http://www.sustainability.ucsb.edu/labrats/labrats-programs/labrats-surplus-chemical-program/). Consider "borrowing" a small quantity of material from another lab at the MRL or UCSB before buying it. Besides saving money and storage space, this sharing can save weeks in executing an experiment. Only order the minimum amount that is sufficient to meet your needs, even if the large quantities are cheaper per unit weight/volume.

It is best practice to label new chemicals with your initials, date received, and date opened (e.g. “KE Rcd. 9/09, Op. 10/09”). This is mandatory for time-sensitive chemicals, most prominently ether solvents (THF, diethyl ether). These must be used or disposed of within 6 months of opening. See also the EH&S Fact Sheet on Time Sensitive Chemicals in Appendix A. Lab users who discover a time-sensitive chemical
that is past due must take action to get it out of the lab and to campus EH&S for proper disposal. Contact Kai Ewert if you require assistance with this process.

Proper Segregation of Incompatible Chemicals

Always segregate chemicals according to their hazard class and incompatibilities. Incompatible chemicals (e.g. acids and bases, oxidizers and fuels) must not be stored together. If keeping them in separate cabinets is not feasible, place one group of chemicals in a plastic tub large enough to contain the chemicals if the containers break.

We separate our chemicals into the following categories. New materials may require additional categories.

- Flammable materials
- Acids
- Bases
- Salts and solids
- Organic reagents

If you are not sure what category some chemical is, ask Kai Ewert. See also the EH&S Fact Sheet on Chemical Storage in Appendix A.

Compressed Gas

Gas cylinders possess all the hazards of the chemical within as well as the hazards of a highly compressed gas. See also the EH&S Fact Sheet on compressed gas cylinders in Appendix A.

All gas cylinders must be secured to a wall with a welded link chain unless they are in the process of being moved. Cylinders must not be moved unless the regulator has been taken off and the metal cap screwed in place.

Users of oxygen cylinders must be constantly aware that pure oxygen is a powerful oxidizer, making many compounds that otherwise burn slowly or not at all burn vigorously!

Additional Information

For additional information, see the EH&S fact sheets on chemical storage, time sensitive materials, and compressed gas cylinders in Appendix A. These are also available on the web at

http://ehs.ucsb.edu/units/labsfty/labrsc/factsheets/lsfacsheets.htm
SOP: Preparing For a New Project

Date of last revision to SOP: Aug. 2014 (Kai Ewert)

PI approval of SOP:

_________________________ (C. R. Safinya) ______________ Date

Campus EH&S, the MRL, and lab supervisors do their best to ensure safety and provide crucial resources to help understand and mitigate any work-related hazards. However, due to the fluid and changing nature of the work performed in an academic setting, ultimately each individual is responsible to ensure that their work is safe for them and everyone nearby.

Before undertaking a new project, lab workers must do whatever research is required to understand the hazards associated with that work. For postdocs and graduate students supervising or mentoring more junior lab members, it is the responsibility of the mentor to make sure that the person supervised understands those hazards, too.

All new projects should begin by considering the health and safety hazards of the materials involved. Safety Data Sheets (SDS; formerly known as Material Safety Data Sheets/MSDS) and LCSS (if available) are good place to start (see the “Resources” and “Identifying Chemical Hazards” parts of this section of the CHP). For chemistry work, an educated guess of what the evolved gases, intermediate compounds, and final products will be is necessary to investigate their hazards as well. If you're not capable of making an educated guess, find someone who is well-acquainted with the chemistry or do a literature search.

If working with chemicals, check if the molecules contain high-energy functional moieties such as azide, nitro, or peroxide groups. Such functional groups may cause the molecule to decompose explosively when exposed to heat or (sometimes even mild) mechanical shock.

Pay particular attention to flash points, inhalation hazards, explosive materials, or air/water sensitive materials. Also be aware of potential chemical incompatibilities that may lead to violent reactions (see also the information / SOP on chemical storage). Determine the appropriate level of personal protective equipment, and match or exceed that level when performing the work.

For all new projects, try to find someone who is doing or has done similar work and get their input. Do not simply emulate their techniques and safety standards, however. Instead, ask questions and form your own opinion.
Get educated on the proper use of any unfamiliar equipment which the new work may require you to use.

Consider what waste the project will generate. If necessary, set up any required new waste containers (see the chemical waste information in this CHP and ask Kai Ewert if you need assistance).
SOP: Chemical Spill Cleanup

Date of last revision to SOP: Aug. 2014 (Kai Ewert)

PI approval of SOP:

_________________________ (C. R. Safinya) ______________ Date

First things first

- Call 9-911 if there is a fire, personal injury, or danger to life or property.

- Assess the extent of danger.
- Help contaminated or injured persons.
- Evacuate the spill area.
- Avoid breathing vapors.
- If possible, confine the spill to a small area using a spill kit or absorbent material.
- Keep others from entering contaminated area (e.g., use caution tape, barriers, etc.).

Chemical Spill Cleanup Procedure

You should NOT clean up a spill if:
- The spill presents an immediate fire hazard
- You don’t know what the spilled material is
- You are unsure about your ability to clean up the spill
- You lack the necessary skills, protection or equipment to clean the spill safely
- The spill is too large to contain
- The spilled material is highly toxic
- Exposure to fumes would result in physical injury
- You feel any symptoms of exposure

(An example would be a mercury spill due to a thermometer that has dropped to the floor)

Instead, do the following in these cases
- alert other workers in the lab
- evacuate the area
- Call 9-911 if spill is immediately health-threatening or else
• Call x3194 (EH&S 24 hr assistance line; you may have to wait up to 15 min for a call back if it is after regular work hours)
• Notify Kai Ewert (805 252 4318)

If it is safe to clean up the spill then follow the steps below for cleanup

Evaluate and Notify
• Assess the toxicity, flammability, and other hazardous properties of the spilled material (if necessary, see labels and / or SDS – safety information resources are provided in this CHP)
• For flammables, remove or turn off all ignition sources such as open flames, motors, pumps, fridges
• Notify other workers in the area
• Notify Kai Ewert or Youli Li as soon as safely possible

Contain and Clean Up
• Wear two layers of gloves, eye protection, and a lab coat. Consider wearing highly impermeable (but “clumsy”) barrier gloves. Wear a face shield (available in the lab, typically on a rack next to the hood housing chemical waste) if you deem it necessary
• Contain and absorb spill using absorbents appropriate for the material (e.g. paper towels, kim wipes, or materials from the spill kit located in room 1012, in the cabinet under the sink next to the hood)
• For volatile materials, focus on minimizing the generation of vapors by transferring soaked adsorbents and adsorbed materials into a fume hood as quickly as possible
• Package waste in a tight-closing container and label it. Include contaminated gloves, clothes, rags, equipment, etc. Store the container with the chemical waste or temporarily in a separate fume hood if necessary.

Followup
• Arrange for the waste to be picked up by EH&S as soon as practical. Contact the lab member responsible for chemical waste disposal or Kai Ewert if you are unfamiliar with the procedure
• Reorder and restock the used cleanup materials if necessary
• Inform EH&S if any personnel was exposed to hazardous chemicals, or if there was release of hazardous material to the drain system
• If there was a significant injury, follow the procedures outlined in the blue emergency flip-charts located in every MRL office and lab (next to the door) under the heading "MEDICAL EMERGENCY" (also listed above, page 16, under “In the Event of an Injury”).
SOP: Evacuated Glass Apparatus

Date of last revision to SOP: Aug. 2014 (Kai Ewert)

PI approval of SOP:

_________________________ (C. R. Safinya) ______________ Date

Scope of SOP

This SOP applies to any evacuated glass, or glass apparatus with a reduced pressure on the inside. Important examples in the lab are rotary evaporators (rotavaps), the cold traps of the vacuum setup, vacuum distillation, and Schlenk lines. Permanently sealed dewars (for holding cryogens) also are evacuated glassware and must always be handled with care.

Hazards

Evacuated glassware can implode if the surface is flawed, and if exposed to physical or thermal shocks, posing a severe risk of injury from flying shards of glass.

Required personal protective equipment

It is imperative that anyone evacuating glass wear eye protection such as ANSI-approved safety glasses, goggles or face shields.

Whenever feasible, evacuated glassware should be contained in a fume hood with the sash lowered.

Preventative measures

Glassware that is intended for evacuation should always be handled carefully to prevent scratches, cracks or chips.

Glassware that is to be evacuated must be inspected before every use to ensure that it does not have any cracks or chips that would be weak spots inviting implosion. Watch for small “stars”, localized star-shaped cracks that can result from setting glassware down on hard surfaces. Mark cracked or chipped glassware and consult the glassblower so see if it can be repaired.
Whenever feasible, evacuated glassware should be covered with plastic mesh, a polymer coating or a covering of (e.g. electrical) tape to minimize release of shards in the event of an implosion.

**Documentation of Training**

(signature of all users is required)

- Prior to conducting any work with evacuated glass apparatus, you must have received training specific to the hazards involved.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP.

I have read and understand the content of this SOP, and have received any additional specific training that I deem necessary:

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SOP: Enclosed Glass with Cryogenic Cooling

Date of last revision to SOP: Aug. 2014 (Kai Ewert)

PI approval of SOP:

_________________________ (C. R. Safinya) ______________ Date

Scope of SOP

This SOP applies to evacuated glass cooled with cryogens (typically liquid nitrogen or isopropanol/dry ice). The most important application of such a setup in the lab are cold traps, e.g. to protect a vacuum pump from vapors.

Hazards

Cryo-cooled glassware poses all the hazards of evacuated glassware (see also the SOP for Evacuated Glass Apparatus): evacuated glassware can implode if the surface is flawed, if exposed to physical or thermal shocks, posing a severe risk of injury from flying shards of glass.

In addition, cryogenic cooling adds other serious hazards. Oxygen can condense at cryogenic temperatures and collect in the apparatus as a blue liquid, e.g. if the cryo-cooled cold traps are open to air without a vacuum being applied. Liquid oxygen, which accumulates preferably because it is less volatile than nitrogen, is a powerful oxidizer which turns many organic materials (e.g. charcoal or sawdust!) into explosives. If a closed cryo-cooled glass apparatus is allowed to warm to room temperature, condensate may rapidly vaporize, resulting in a rapid pressure buildup and possibly explosion of the glass apparatus. Additionally, cryogens as well as surfaces cooled by these pose an injury hazard due to their very low temperature. Cryogens also cause many materials to become very brittle and thus more susceptible to mechanical damage.

Required personal protective equipment

Suitable eye protection, such as ANSI-approved safety glasses, goggles or face shields, is mandatory.

Appropriate gloves must be worn when handling cryogens. A pair of gloves for handling of cryogens should be available near the -70 °C freezer in room 1032.
Other safety precautions

Whenever feasible, cryo-cooled glassware should be contained in a fume hood with the sash lowered.

Everyone using cryogenically chilled glass vessels must be vigilant, checking for leaks and condensates, especially oxygen from air. If condensation of oxygen (accumulation of a blue liquid) is observed, the procedure must be stopped; the apparatus must be vented to air, and allowed to warm to room temperature in a fume hood.

Any vessel that has been cryogenically cooled and evacuated must only be warmed slowly and should be vented while warming to allow condensates to evaporate slowly.

Additional Information

See the EH&S fact sheet on cryogens in Appendix A. The fact sheet is also available on the web at

Documentation of Training

(signature of all users is required)

- Prior to conducting any work with enclosed glass apparatus with cryogenic cooling, you must have received training specific to the hazards involved.
- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP.

I have read and understand the content of this SOP, and have received any additional specific training that I deem necessary:

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Appendix A: EH&S laboratory safety fact sheets

The following EH&S laboratory safety fact sheets are attached (accessed on 9/15/09 via http://ehs.ucsb.edu/units/labsfty/labrcsc/factsheets/lsfacshets.htm):

- Acrylamide
- Autoclaves
- Azides, Handling Organic
- Benzene
- Biological Waste Disposal
- Carcinogen Control
- Centrifuge
- Chemical Storage
- Chemical Waste Disposal
- Chlorinated Solvents
- Compressed Gas Cylinders
- Corrosives
- Cryogens
- Dichloromethane (also known as methylene chloride)
- Electrophoresis Equipment
- Ethidium Bromide Safety
- Formaldehyde
- Fume Hood Usage Guidelines
- Housekeeping Guide for labs
- Lab Coats
- Phenol
- Power Failures Guide
- Refrigerator & Freezers in Lab
- Seismic Hazard Reduction
- Sharps Disposal
- Time-Sensitive Chemicals
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Use of Acrylamide

Acrylamide is used in powder/dry form for making electrophoresis gels. Acrylamide monomer is highly toxic by inhalation and via skin contact (can penetrate unbroken skin easily); also a suspected carcinogen. The polymer is not generally considered as toxic.

**Personal Protective Equipment:** Gloves should be used when potential for skin contact exists. Nitrile, 4H™, Silver Shield™, viton, PVC, or butyl rubber gloves should be worn. However, per NIOSH, these recommendations are NOT valid for very thin nitrile and PVC gloves (0.3 mm or less). Safety glasses with side shields, or goggles should be worn. A laboratory coat should also be worn.

**Engineering/Ventilation Controls:** Use process enclosures, local exhaust ventilation, or other engineering controls such a fume hood or weighing hood to reduce dust concentrations as low as reasonably achievable. Engineering controls should be used whenever feasible to maintain airborne acrylamide concentrations at the lowest achievable levels.

**Special Handling Procedures and Storage Requirements:**
Powder easily becomes airborne and may result in personal exposure and area contamination. Use care to avoid dispersing dust. Keep container tightly closed to prevent acrylamide from subliming and entering the atmosphere. Store in cool place. Keep from contact with oxidizing materials, reducing agents, acids, bases, metal and contaminants.

**Spill and Accident Procedures:** Wear appropriate protective clothing. If potential respiratory hazard exists call EH&S (x-4899). Collect spills into appropriate waste container. Avoid creation of airborne dust. Small liquid spill: Absorb with non-combustible absorbent materials and place into containers for later disposal. Treat site with 1.6% potassium persulfate, then with 1.6 % sodium metabisulfite. Let stand for 30 minutes, then wash with plenty of water. **Small dry Spill:** Scrape material into clean, dry containers and cover. Do create airborne dust. Treat site with 1.6% potassium persulfate, then with 1.6 % sodium metabisulfite. Let stand for 30 minutes, then wash with plenty of water. **Large spill:** Notify others in room of spill. Evacuate room/immediate area. Call EH&S for cleanup (x-3194). Post room with warning notifying others of spill. Prevent unnecessary entry into area until arrival of EH&S response team. Provide assistance and information to spill responders.

**Waste Disposal:** Dispose of waste through EH&S.

**Decontamination:** Periodically treat area where unpolymerized acrylamide is used with 1.6% potassium persulfate, then with 1.6 % sodium metabisulfite. Let stand for 30 minutes, then wash with plenty of water.

**Designated Use Area:** Recommended.
Autoclaves are safe and highly effective when used properly. They sterilize equipment and supplies, killing biological contamination and denaturing proteins. Autoclaves will not remove chemical contamination.

There are three basic autoclave cycles

1. **Gravity** or “Fast Exhaust” cycle - For dry goods, glassware, etc. This cycle charges the chamber with steam and holds it at a set temperature for a set period of time. At the end of the cycle a valve opens and the chamber rapidly returns to atmospheric pressure. Drying time may also be added to the end of the cycle.

2. **Liquid** or “Slow exhaust” cycle - Used to prevent sterilized liquids from boiling, steam is exhausted slowly at the end of the cycle, allowing the liquids (which will be super-heated) to cool.

3. **Pre-Vacuum** cycle - For porous materials, animal bedding, etc. This cycle partially evacuates the chamber prior to introducing steam for greater steam penetration. Pre-vacuum cycles are not available on all machines.

Follow all local procedures for using autoclaves and biological waste treatment. At a minimum they must meet these procedures:

- Sterilization requires temperatures of at least 121-124 C (250-255 F). The chamber should reach 90% of full temperature in 5 minutes.

- Handle hot glassware with care, using dry, heat resistant gloves to remove items.

- Use “slow exhaust” or “liquid cycle” or equivalent for liquids and let them stand for 10 min.

- Always use some type of secondary containment, typically polypropylene or stainless steel tubs. This will eliminate the primary cause of damage to the machines.

- Always follow written lab procedures; however, dry goods typically require about 30 minutes sterilization, plus about 20 minutes drying time (dry time may need to be increased for enclosed items such as pipette tips or bottles with lids).

- Average liquid sterilization times (add an additional 10-20 minutes for crowded items):

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<th>Capacity</th>
<th>Time</th>
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<td>&lt;500 ml</td>
<td>30 minutes</td>
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<tr>
<td>500 ml - 1 L</td>
<td>40 minutes</td>
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<tr>
<td>2 L – 4L</td>
<td>55 minutes</td>
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<tr>
<td>4L</td>
<td>1 hour</td>
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• Not all plastics can be autoclaved. Polypropylene and polycarbonate will survive, but polyethylene and high density polyethylene will not. Different types of plastic can be identified by looking for initials imprinted on bottom of containers (PP=polypropylene, PC=polycarbonate, PE=polyethylene, HDPE=high density polyethylene). If you are unsure about a new container, place it in an autoclave safe container the first time.

• To prevent bottle bottoms from breaking, place them in a tub with 1-2 in. of water.

• Autoclaving new glassware for 90 min. will partially temper it, increasing its strength.

**General Autoclave Use Procedures**

• Do not open any autoclave until the pressure gauge labeled “chamber” is at zero, stand back and allow steam to escape through the open door before reaching in.

• Never open an autoclave set for “slow exhaust” until the cycle is complete. Superheated liquids can boil over, possibly damaging both autoclave and operator. After the cycle is complete, let liquids stand 10 minutes more, movement could cause liquids to boil.

• Pyrex bottles, empty or full, should have their caps placed on loosely, to prevent explosion due to expansion. Use tinfoil to cover non-safety-glass bottles (non-Pyrex).

• To ensure adequate steam penetration when treating biological waste, add 1 cup of water to dry loads and close the top of the bags, leaving a one-inch opening.

*For further information, contact the EH&S Laboratory Safety Specialist at x-4899*
Synthesizing, Purifying, and Handling Organic Azides

Organic azides are potentially-explosive substances that can and will decompose with the slightest input of energy from external sources (heat, light, pressure). Additionally, small molecules containing the azido functionality tend to decompose violently which may result in injury if proper safety precautions are not utilized.

Organic azides have received renewed interest for their shear diversity of potential organic transformations but also in no small part to the recent introduction of the concept of ‘Click Chemistry.’ This renewed interest must be paralleled with a reiteration of the safety precautions one must undertake. In addition to summarizing the multitude of these synthetic transformations in which azide can participate, recent reviews have also outlined safety precautions one should take when utilizing these energy-rich molecules. These manuscripts should be mandatory reading for anyone working with, or around azides.

Obtained by simple nucleophilic displacement of a halogen or by copper (I)-catalyzed aryl coupling, organic azides can be prepared, purified, and handled safely provided one takes the following precautions:

**NaN₃:**
- Azide ion has a similar toxicity as that of cyanide ion (LD₅₀ = 27 mg/kg for rats). Be sure to use appropriate gloves when weighing azido salts.
- Sodium azide reacts violently with several common laboratory organics such as: CS₂, bromine, Bronstead acids, and heavy metals. When attempting a new reaction, be relentless in your background research to determine the reactivity of sodium azide to ALL reaction components.
- NEVER use chlorinated solvents as reaction media! Utilizing dichloromethane or chloroform will result in the formation of explosively-unstable di- and tri- azidomethane, respectively (refer to section on C/N ratios below).
- Heavy metals (e.g., Cu, Pb, Ba) form shock and pressure sensitive compounds with azide anions. This may affect us in that an ‘azide residue’ may form of metal parts.

**Organic Azides:**
- All organic azides decompose with introduction of external energy. Any azide synthesized should be stored below room temperature (-18°C) and in the dark.
- When designing your target azide, keep in mind the following equation. Notice that this equation takes into account all nitrogen atoms in your azide, not just those in the azido group. \( N \) signifies the number of atoms.
\[ \frac{N_C + N_O}{N_N} \geq 3 \]  
(eq. 1)

- In practice, organic azides that contradict the above equation can be made, and in some cases, be stored safely. Consider the following points as strict guidelines in the preparation and storage of organic azides. As with all synthetic procedures a small scale (ca. 0.5-1.0 gram) should be run first to determine the nature of the product:

  - \( n \)-nonyl azide (C/N=3) will be the smallest azide isolated and stored in its pure form. This azide, when stored properly, can be done so in multigram quantities (up to 20 grams). In practice, the octyl derivative is equally safe (C/N=2.7).

  - Azides smaller than C/N=3 (but greater than C/N=1) can be synthesized and isolated, but by no means should these molecules be stored in its highest purity. Rather, if storage is necessary store these azides as solutions below room temperature (concentrated to no more than 1M, less than 5 grams material).

  - Under no circumstances should azides with C/N < 1 be isolated. However, these molecules may only even be considered for synthesis if the azide is a transient intermediate species, AND the limiting reagent in the reaction mixture, AND with maximum quantities of 1 grams. For instance, methyl azide can be synthesized in situ and immediately reacted with an excess of a terminal acetylene.\(^1\)

- Never use distillation or sublimation as purification techniques! Purification should be limited to extraction and precipitation. Column chromatography may contribute to decomposition so only purify azides that satisfy equation 1.

- Organic azide waste should be placed in a separate, explicitly-labeled container designated solely for azide waste. Extra caution must be taken to make certain that azide waste not come in contact with acid. Acids will protonate the azide ion and from the highly-toxic hydrogen azide (toxicity similar to that of hydrogen cyanide).

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\(^4\) Feldman, A.K.; Colasson, B.; Fokin, V.V. *Org. Lett.* 2004, 6, 3897. Thibault et al. manuscript in preparation
Exposure to benzene puts you at increased risk of developing leukemia and other blood disorders. It can effect the central nervous system and cause irritation to the respiratory tract and skin/eye. Exposure may occur through inhalation, skin absorption or ingestion.

Benzene is one of few chemicals with a specific regulatory standard written to protect workers. Cal-OSHA Permissible Exposure Limits for benzene (see below) are very low and violations of the standard can result in fines. To remain below the benzene PEL, workers must always work in a fume hood, glove box or with sealed containers and in conjunction with adequate personal protective equipment. It is the responsibility of the lab supervisor/PI to ensure that all legally-required protections are in place and understood by their workers. Contact EH&S if your lab can not meet these requirements.

Exposure Hazards of Benzene

Long-Term Effects of Exposure
Animal studies and the occurrence of disease in human work forces show a linkage between benzene exposure and cancer, including leukemia - plus other blood disorders like anemia. It is listed as a known human carcinogen by the International Agency on Research of Cancer and the National Toxicology Program.

Short-Term Effects of Exposure
- **Inhalation** - benzene is volatile and inhalation is therefore a major route of exposure. Low-level exposures can cause dizziness, headache, nausea, and irritation to the respiratory tract. Other symptoms can include feelings of breathlessness, irritability and euphoria. High exposures can cause convulsions or coma. The odor threshold for benzene is 60 ppm, although individual sensitivity will vary. However, given that toxic effects will occur at much lower levels (see below), lack of odor can not be used as an indicator of safety.

- **Skin contact** - may irritate skin. Can cause dermatitis (chapping, drying, rashes) on repeated contact with skin.

- **Eye contact** – vapors irritate the eyes, with eye splash causing serious irritation.

Cal-OSHA Legal Limits for Exposure
- **Permissible Exposure Limit (inhalation)**: 1 ppm (8 hr time weighted average)
- **Short-term Exposure Limit (inhalation)**: 5 ppm (15 minutes)
- **Action Level (inhalation)**: 0.5 ppm

If EH&S believes your exposure to benzene may exceed these levels, UCSB must monitor your exposure level. If monitoring confirms that your exposure is above-limits, then a medical surveillance program must be made available to you at no cost, and/or we must reduce your exposure below these limits.
Controlling Exposures

Engineering Controls
Benzene should *never* be used without adequate ventilation. It should always be used in a properly functioning *fume hood, glove box or in a sealed system.*

Protective Equipment and Clothing
- *Gloves* – the gloves commonly found in campus labs/storerooms (nitrile, neoprene and latex) are **not recommended** for use with benzene due to the ease with which it permeates through those glove materials. 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.

- *Eyewear* - safety glasses or goggles should be worn as with any chemical

- *Respirator* – if a fume hood is available then a respirator is not needed. If a respirator is needed for special circumstances, prior to using one, you must first contact EH&S (x-8787) to enter the UCSB Respiratory Protection Program to satisfy current Cal-OSHA requirements.

Other Requirements

**Material Safety Data Sheets (MSDS)** - Per Cal-OSHA, chemical-users users must know what MSDS are, their relevance to health and safety and how to readily access them. These issues are covered in the *EH&S Lab Safety Orientation*. Regular users of benzene should have a hard copy MSDS available - see the EH&S website for electronic access. The MSDS will cover the benzene issues above and many others (e.g. flammability, spill clean-up, etc.)

**Chemical Hygiene Plan** – Per Cal-OSHA, benzene is considered a *Particularly Hazardous Substance*. Therefore, its safe use must be addressed in your lab’s written *Chemical Hygiene Plan* (CHP). Since many safety issues are addressed generically in this fact sheet, it can be used as a resource in developing your CHP. Lab supervisors/PIs should contact EH&S at x-4899 if you need an orientation to this requirement.
MEDICAL WASTE: Research Waste Associated with Human Pathogens OR Human Tissue or Fluids
ALL medical waste treated in autoclaves must be logged at the autoclave location. If there is no log present, contact the EH&S Biosafety Officer at x 8894.

All wastes that are classified as medical waste must be stored, handled, transported and treated in accordance with the Medical Waste Management Act, and as detailed by the lab specific Biohazard Use Authorization.

LABORATORY GLASS:
Any item that could puncture regular waste bags and endanger waste handlers (eg. Pipettes). DO NOT pick up broken glass with your hands, if possible. Wear cut-resistance gloves and use a broom. Collect broken glass as carefully and completely as possible. If this is medical waste as described above, place into a hardwalled sharps container (red with biohazard label), treat, remove biohazard label, and dispose as solid waste.

BIOLOGICAL WASTE (Cell Cultures, etc.):
Any material that once contained or now contains living organisms, or that is a product, portion, or waste of a living or once-living organism.
• Liquids or semiliquids are treated with a chemical biocide appropriate to the organism. Drain dispose after 30 minutes contact time.
• Solid wastes are treated in an autoclave per operating instructions, then rebagged in an ordinary garbage bag for disposal as solid waste.

BLOOD AND BODY FLUIDS:
• Treat fluids with bleach (10% final volume) and pour into a sink drain connected to the campus sewage system. DO NOT pour into a storm drain.
• Place solid waste in autoclavable bags with autoclave tape and autoclave. DO NOT dispose of containers of liquids in garbage cans or dumpsters.
• Dispose of autoclaved waste in solid waste container.
• There should be no dripping or leakage of liquid from bagged waste
• Dispose of solid autoclaved waste in solid waste container.

AUTOCLAVE CLASS IS AVAILABLE BY CALLING BOB FLETCHER AT X-2513
Since cancer in humans may result from exposure to chemical carcinogens, the following guidelines are designed to keep worker and environmental exposure to a minimum. In this two phase approach, good work practice is backed up by engineering controls. Good work practice is the primary method of protecting laboratory personnel from exposure to carcinogens.

• Substitute non-carcinogenic substances for chemical carcinogens wherever possible.

• Use and keep on hand very small quantities or dilute solutions of chemical carcinogens.

• Avoid inhalation as route of exposure:
  – Contain carcinogens in a fume hood or glove box.
  – Avoid practices which produce aerosols (blow-out pipets, sonicators, heating, stirring, pouring or weighing). Conduct these operations in a closed system).
  – Dry sweeping or dry mopping in the area is prohibited.
  – Wear EH&S approved respirators in areas where exposure may exceed the permissible level. Respirator users must be fit tested and approved by EH&S.

• Avoid skin contact as a route of exposure:
  – Wear gloves appropriate for the task. Change gloves often and remove before leaving the regulated area.
  – Wear a lab coat, but remove prior to leaving the controlled area.
  – Clean up spills and contaminated containers as soon as discovered.
  – Wash hands and arms after each use of chemical carcinogens.
  – Clean work surfaces after each procedure and at the end of the work day.
  – Shower immediately after any overt exposure to chemical carcinogens.

• Avoid ingestion as a route of exposure:
  – Do not eat, drink, or smoke in the lab.
  – Use mechanical pipettes. Do not mouth pipette.
  – Thoroughly wash hands and arms before eating or smoking.

• Chemical Carcinogen Waste Disposal:
  – EH&S will pick up carcinogen waste for proper disposal.
  – Do not dump carcinogens or toxic materials down the drain or evaporate
  – Do not dump carcinogens in the trash.
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*
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>
</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**—fuels are reducing agents

<table>
<thead>
<tr>
<th>Solids</th>
<th>Liquids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>Ethyl Acetate</td>
</tr>
<tr>
<td>Benzene</td>
<td>Ethyl Ether</td>
</tr>
<tr>
<td>Cyclohexane</td>
<td>Gasoline</td>
</tr>
<tr>
<td>Ethanol</td>
<td>Hexane</td>
</tr>
<tr>
<td>Isopropyl Alcohol</td>
<td>Toluene</td>
</tr>
<tr>
<td>Methanol</td>
<td>Xylene</td>
</tr>
</tbody>
</table>

**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**—react violently with organics.

<table>
<thead>
<tr>
<th>Solids</th>
<th>Liquids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium Hypochlorite</td>
<td>Bromine</td>
</tr>
<tr>
<td>Ferric Chloride</td>
<td>Hydrogen Peroxide</td>
</tr>
<tr>
<td>Iodine</td>
<td>Nitric Acid</td>
</tr>
<tr>
<td>Nitrate, Salts of</td>
<td>Perchloric Acid</td>
</tr>
<tr>
<td>Peroxide, Salts of</td>
<td>Chromic Acid</td>
</tr>
<tr>
<td>Potassium Ferricyanide</td>
<td></td>
</tr>
<tr>
<td>Sodium Nitrite</td>
<td></td>
</tr>
</tbody>
</table>

**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.

**PEROXIDE-FORMING CHEMICALS**—peroxides can be explosive and shock-sensitive.

<table>
<thead>
<tr>
<th>Solids</th>
<th>Liquids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyanides, Salts of</td>
<td></td>
</tr>
<tr>
<td>Sulfides, Salts of</td>
<td></td>
</tr>
</tbody>
</table>

**Storage Precautions:**
- Dispose before expected date of initial peroxide formation.
- Label containers with receiving, opening, and disposal dates.
- Store in airtight containers in a dark, cool, and dry place.

**PYROPHORIC SUBSTANCES**—spontaneously ignite in air.

<table>
<thead>
<tr>
<th>Solids</th>
<th>Liquids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some finely divided metals</td>
<td></td>
</tr>
<tr>
<td>Some organoaluminum compounds (LiAlH₄, Al(CH₃)₃)</td>
<td></td>
</tr>
<tr>
<td>Silane</td>
<td></td>
</tr>
<tr>
<td>Phosphorus, Yellow</td>
<td></td>
</tr>
<tr>
<td>Phosphorus, yellow should be stored and cut under water</td>
<td></td>
</tr>
</tbody>
</table>

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

**WATER REACTIVE CHEMICALS**—reacts violently with water to yield flammable or toxic gases.

<table>
<thead>
<tr>
<th>Solids</th>
<th>Liquids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium Carbide</td>
<td>Phosphorus Trichloride</td>
</tr>
<tr>
<td>Lithium</td>
<td>Thionyl Chloride</td>
</tr>
<tr>
<td>Magnesium</td>
<td></td>
</tr>
<tr>
<td>Potassium</td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td></td>
</tr>
<tr>
<td>Lithium, Potassium, and Sodium should be stored under Kerosene or Mineral Oil</td>
<td></td>
</tr>
</tbody>
</table>

**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/labsc/chemistry/lschem.htm

<table>
<thead>
<tr>
<th>Solids</th>
<th>Liquids</th>
<th>Gases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formaldehyde</td>
<td>Carbon disulfide</td>
<td>Store in a gas cabinet or other ventilated cabinet</td>
</tr>
<tr>
<td>Nickel carboxyl</td>
<td>Cyanide solutions</td>
<td></td>
</tr>
</tbody>
</table>

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

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

- Cyanides, Salts of
- Sulfides, Salts of

http://www.ehs.ucsb.edu/units/labsfty/labsc/chemistry/lschem.htm
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.
• 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.

Further information contact EH&S Hazardous Waste Program X3293
LABORATORY SAFETY FACT SHEET #15
Chlorinated Solvents

Examples: methylene chloride, chloroform, trichloroethylene, dichloroethylene

Hazards

• Most of these compounds have an anesthetic or narcotic effect, causing people to feel intoxicated if overexposed. This can be particularly dangerous when working around machinery, as judgment and coordination can be impaired.

• Some of the chlorinated solvents are strong systemic poisons which damage the liver, kidneys, nervous system, and other organ system. These symptoms most often appear gradually, with nausea, loss of appetite, vomiting, headaches, weakness, and mental confusion most common.

• All chlorinated solvents can cause dermatitis (chapping, drying, rashes) on repeated contact with the skin, since they remove the protective fats and oils. Gloves appropriate for a particular chlorinated solvent should be determined by consulting a glove reference chart – see EH&S website under Programs/Lab Safety/Personal Protective Equipment.

• Many of the compounds are highly irritating to the membranes around the eyes, and in the nose, throat, and lungs. Examples of chlorinated solvents which have irritating properties are ethylene dichloride and chloroform.

• In studies on laboratory animals, many chlorinated hydrocarbons have been linked to the development of cancer in animals; examples of these compounds are: ethylene dichloride, perchloroethylene, chloroform and methylene chloride.

• When excessively heated, chlorinated solvents can decompose, forming highly toxic fumes such as phosgene, hydrochloric acid, and chlorine.

• With few exceptions, most of the chlorinated hydrocarbons are non-flammable.

Work Practices: as with all volatile hazardous materials, chlorinated solvents must always be used in a fume hood or with other local exhaust ventilation such as an approved snorkel. Inhalation of the vapors is not an acceptable work practice.

For further information, contact the EH&S Laboratory Safety Specialist at x-4899
Compressed Gas Cylinders

Compressed gas cylinders must be handled carefully by trained individuals. The diffusive nature of gas can result in serious hazards over large areas. Gas cylinders can be hazardous because 1) if they are mishandled, they can become “unguided missiles” with enough explosive force to go through concrete walls due to the high pressure inside the tank. 2) they often contain materials which are inherently toxic or highly flammable. For these reasons, particular care must be exercised with compressed gases.

**Toxic and flammable gases** have stringent and specific requirements for use and storage. UCSB has developed a Campus Toxic Gas Program, the requirements of which exceed the reach of this manual. All new installations must meet this requirements prior to use. Many of the campus labs using these gases have been and will be retrofitted to comply with current Fire Code regulations. Examples of some of the more common lab gases which fall under the provisions of this program include: fluorine, ammonia, diborane, ethylene oxide, nitric oxide, nickel carbonyl, phosgene and silane. Call the EH&S Lab Safety Specialist at x4899 for additional details.

**Transport**
- To transport or move a cylinder, strap it to a **handtruck** in an upright position.
- Make sure the **valve protection cap** and outlet plug are in place. Leave the valve protection cap on at all times, unless the cylinder is in use.
- Do not move a cylinder by rolling, dragging or walking it across the floor. Never leave a cylinder free-standing.
- Never drop cylinders or bang them against each other or another object.

**Storage**
- All cylinders must be secured upright with **chains and brackets** bolted to a solid structural member. Chains should be 3/16 inch welded link or equivalent. At least one chain must be used to secure each cylinder at a point two-thirds up the cylinders height. C-clamp bench attachments and fiber/web straps are not acceptable because they are not seismically sound. Any variations of these requirements must be approved by EH&S. (Campus Policy 5445)
- Keep cylinders away from heat and sources of ignition. Do not place cylinder where contact with any electrical circuit can occur. Protect cylinders from weather extremes, dampness and direct sunlight.
- Inspect cylinders and delivery equipment routinely for signs of wear, corrosion, or damage.
- All cylinders must be clearly labeled as to their contents — do not use unlabeled cylinders and do not rely on color coding for identification.
- Understand that “Empty” implies “end of service” and as such, the cylinder may still have greater than 25 psig of pressure remaining.

**Leaks**
- If the material in the tank is **toxic or flammable** and you suspect a leak, get everyone out of the area and report it to EH&S at x3194 and Dispatch at 9-911.
Use

• Gas delivery systems involving toxic gases must be authorized by EH&S prior to installation and operation.

• Use regulators designed for a specific gas. (Consult your gas vendor or catalog for proper regulator compressed gas association (CGA) number (on nut) for use with corresponding compressed gas cylinder. Do not use any adapter between cylinders and regulators.

• Post signs in laboratory area when using corrosive, toxic or flammable gases. The door placard system maintained by EH&S on the campus may be used for this.

• Never modify, adapt, force or lubricate safety devices, cylinder valve or regulator.

• Do not allow grease or oil to come into contact with oxygen cylinder valves, regulators, gauges or fittings. An explosion or fire can result. Oxygen cylinders and apparatus must be handled with clean hands and tools. Remember that oxygen supports and greatly accelerates combustion.

• Never force a gas cylinder valve — if it cannot be opened by the wheel or small wrench provided, the cylinder should be returned.

• When opening cylinder valve, do not hold regulator. Stand with valve between you and regulator. Open cylinder valves slowly, directed away from your face.

• Release a compressed gas gently to avoid build-up of static charge which could ignite a combustible gas.

• Special precautions are necessary for acetylene usage. Note that acetylene can form explosive compounds in contact with copper or brass. Consult the vendor or manufacturer for proper operating equipment and procedures.

• Do not extinguish a flame involving a highly combustible gas until source of gas has been shut off. Re-ignition can cause an explosion.

Disposal

• Empty cylinders should be labeled “EMPTY” or “MT. Always leave at least 25 psi minimum pressure in all “EMPTY” cylinders to prevent contamination and the formation of explosive mixtures.

• Return damaged or corroded cylinders and cylinders with a test date more than five years old stamped on the shoulder to the vendor. Some gas cylinders should be disposed or returned at shorter intervals (e.g., corrosives should be disposed or returned every six months since they readily attack the cylinder fittings).

For further information, contact the EH&S Laboratory Safety Specialist at x-4899
LAboratory safety fact sheet #18
Corrosives (Acids and Bases)

Examples:

Acids –
Solids: benzoic acid, sulfamic acid. Liquids: acetic acid, nitric acid, phenol, sulfuric acid.
Gases: hydrogen chloride, hydrogen fluoride, hydrogen bromide, chlorine, and sulfur dioxide

Bases-
Solids: sodium, potassium bismuth, and calcium hydroxides.
Liquids: ammonium hydroxide, bromine, potassium hydroxide.
Gases: ammonia

Hazard Properties:

• Corrosives can seriously burn body tissue on contact as well as cause dermatitis and eye damage.

• Exposure to vapors or mists can affect the respiratory tract and mucous membranes.

• Corrosives are not flammable, but they can react with each other and with other chemicals, causing potential fire and explosion.

• Contact with ordinary materials such as paper and wood may generate sufficient heat to ignite; especially true for oxidizing acids such as nitric and perchloric.

• Many corrosives may cause delayed injury, particularly bases. The absence of immediate symptoms may prolong exposure and as a result, cause even more severe injuries.

Practices:

• Be aware of the nearest eyewash station and emergency shower. If a chemical splash occurs, flush with running water for at least 15 minutes and seek medical attention.

• Use chemical splash goggles or other eye protection when working with acids/bases. Appropriate acid- and base-resistant protective clothing, including aprons, lab coats, and gloves, should also be worn.

• When diluting acids or bases with water, always pour the reagent slowly (while mixing) into the water, never the reverse.

• Hydrofluoric acid can cause severe chemical burns. See the EH&S website:
   http://ehs.ucsb.edu/units/labsfty/labsc/factsheets/lsfactsheets.htm
for specific information on a recommended first-aid treatment paste that regular HF users should have on hand.

• Whenever acid, base or solvent bottles are carried from the laboratory, the bottles should be placed in buckets which act as secondary protective containers.

For further information, contact the EH&S Laboratory Safety Specialist at x-4899
Cryogens

Examples: Liquid oxygen, liquid nitrogen, liquid helium, dry ice

Hazard Properties
- These materials 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 will displace the air within a non-ventilated space possibly leading to suffocation. Generally, labs have adequate ventilation to prevent this.

- 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.

Practices
- Do not move an over-pressurized container. Evacuate and seal area, call EH&S (x3194) or dial 9-911.

- 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.

- Cool cryogenic containers slowly to reduce thermal shock and flashing of the material.

- Cryogen handlers should be protected by a face shield or safety goggles, lab coat or apron and gloves or mitts.

- When utilizing cold baths with solvents, 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 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.

- Liquid helium requires approved handling techniques and equipment due to over-pressurization hazards and icing.
Freezing and Thawing Specimens

Cryogenic ampules can be very dangerous if they have not been properly sealed, exploding violently after removal from liquid nitrogen storage. Cells and virus stocks should be stored in sealed ampules and not in screw cap glass vials. Screw cap glass vials are permeable to liquid nitrogen (approximately 50% of the time) and therefore represent a source of contamination in the storage tank. Plastic screw cap ampules also leak and must be used with a heat sealed sleeve. Upon thawing, sealed glass vials may explode, producing an aerosol of glass and cell debris. If freezing manually, place ampules in the bottom of a beaker, cover with methanol and a dye, e.g., methylene blue, and transfer the entire beaker from refrigerator to freezer. The methanol provides even freezing and the dye will penetrate imperfectly sealed vials permitting their identification and elimination. When thawing cells, a lab coat, face guard and gloves must be worn. Ampules to be thawed should be dropped into a plastic beaker containing 70% ethanol at 37°C within a spongy bucket and covered immediately. The volatility of many of the solvents used require the use of a ventilated enclosure for vapor capture.

For further information, contact the EH&S Laboratory Safety Specialist at x-4899
Exposure to dichloromethane (DM) – also known as methylene chloride - puts you at increased risk of developing cancer, adverse effects to the heart, central nervous system, liver and skin/eye irritation. Exposure may occur readily through inhalation or by skin absorption.

DM is one of few chemicals that has a specific regulatory standard written to protect workers. Cal-OSHA Permissible Exposure Limits for DM (see below) are low and violations of the standard can result in fines. To remain below the DM PEL, workers must always work in a fume hood, glove box or with sealed containers and in conjunction with adequate personal protective equipment. It is the responsibility of the lab supervisor/PI to ensure that all legally-required protections are in place and understood by their workers. Contact EH&S if your lab can not meet these requirements.

Exposure Hazards of Dichloromethane

Long-Term Effects of Exposure (Carcinogenicity)
Animal studies and the occurrence of disease in human work forces show a linkage between DM exposure and cancer. DM is listed as a suspected human carcinogen by the International Agency on Research of Cancer and the National Toxicology Program.

Short-Term Effects of Exposure
- Inhalation - DM is highly volatile and inhalation is therefore a major route of exposure. It can irritate the nose, throat and lungs. It also has an anesthetic or narcotic effect, causing people to feel intoxicated if overexposed. Higher exposures can cause a build-up of fluid in the lungs. A concentration of 50,000 ppm is immediately dangerous to life and health from asphyxiation.

- Skin contact - may irritate and burn. Can cause dermatitis (chapping, drying, rashes) on repeated contact with skin. May be absorbed through intact skin and readily passes through the blood-brain barrier to exert effects on the nervous system.

- Eye contact - can cause injuries ranging from transient discomfort and irritation to severe irritation with high exposures.

Cal-OSHA Legal Limits for Exposure
- 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 (more than 30 days a year)

If EH&S, believes your exposure to DM may exceed these levels, UCSB must monitor your exposure level. If monitoring confirms that your exposure is above-limits, then a medical surveillance program must be made available to you at no cost, and/or your exposure must be reduced/eliminated.
Controlling Exposures

Engineering Controls
DM should never be used without adequate ventilation. It should always be used in a properly functioning fume hood, glove box or in a sealed system.

Protective Equipment and Clothing
• Gloves – the most common gloves found in campus labs/storerooms (nitrile, neoprene and latex) are not recommended for use with DM 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.

• Eyewear - safety glasses or goggles should be worn as with any chemical

• Respirator – if a fume hood is available then a respirator is not needed. If a respirator is needed for special circumstances, prior to using one, you must first contact EH&S (x-8787) to enter the UCSB Respiratory Protection Program to satisfy current Cal-OSHA requirements.

Other Requirements

Material Safety Data Sheets (MSDS) - Per Cal-OSHA, chemical-users users must know what MSDS are, their relevance to health and safety and how to readily access them. These issues are all covered in the EH&S Lab Safety Orientation. Regular users of DM should have a hard copy MSDS available - see the EH&S website for electronic access. The MSDS will cover the issues above and many others (e.g., flammability, spill clean-up, etc.).

Chemical Hygiene Plan – Per Cal-OSHA, dichloromethane is considered a Particularly Hazardous Substance. Therefore, its safe use must be addressed in your laboratory’s written Chemical Hygiene Plan (CHP). Since many safety issues are addressed generically in this document, it can be used as a resource in developing your CHP. Lab supervisors/PIs should contact EH&S at x-4899 if you need an orientation to this requirement.
Guidelines for Safe Use of Electrophoresis Equipment

Electrophoresis units can present several types of hazards including electrical, chemical, and sometimes radiological. The general information presented here, however, should not be viewed as a substitute for the specific owner’s manual and instructions provided by the manufacturer. Below is a link to an accompanying checklist to assist researchers in safely operating electrophoresis units.

**Proper Equipment Set-Up**
Place electrophoresis units and their power supplies so that the on/off switch is easy to reach and the power-indicator lights are easily seen. Locate the equipment where it will not be easy to knock over or trip on.

Because electrophoresis work involves handling conductive liquids around electricity, power supplies should be protected by ground fault circuit interrupters (GFCIs). GFCIs act as very sensitive circuit breakers and, in the event of a short circuit, will stop the power before it can hurt a person. You can identify GFCIs by their “test” and “reset” buttons. They are found on some outlets or breaker boxes. An adapter type, which plugs into a standard outlet and does not require installation by an electrician, can be purchased at local hardware stores at prices starting at $20.

**Addressing Electrical Hazards**
Electrophoresis units use very high voltage (approximately 2000 volts) and potentially hazardous current (80 milliamps or more). This high power output has the potential to cause a fatal electrical shock if not properly handled.

Routinely inspect electrophoresis units and their power supplies to ensure that they are working properly. Power supplies should be inspected to ensure that all switches and lights are in proper working condition, that power cords and leads are undamaged and properly insulated, and that “Danger—High Voltage” warning signs are in place on the power supply and buffer tanks.

Inspect the buffer tanks for cracks or leaks, exposed connectors, or missing covers. If your units have such hazards, replace the units with new models that have these safety features built in, or contact EH&S for information on individuals approved to perform retrofitting.

**Training and Work Procedures**
Principal investigators are responsible for providing instruction on the safe use of electrophoresis units to those in the laboratory who work with them. The instruction should cover the operating procedures written by the manufacturer or laboratory, as well as the associated hazards, the correct personal protective equipment, and applicable emergency procedures. As with all safety training, this instruction should be documented.

Employees must wear all appropriate personal protective equipment when working with electrophoresis units, including lab coats, gloves, and eye protection.
Do not leave electrophoresis units unattended for long periods of time since unauthorized persons may accidentally come in contact with the unit, or the buffer tank liquid may evaporate, risking a fire.

Labs that perform electrophoresis work during off-hours should consider using a “buddy system” to ensure that emergency services can be notified if someone is injured or exposed. It is also recommended that laboratory personnel be trained in CPR and in First Aid.

An **Electrophoresis Safety Checklist** is available via the UC Berkeley website at:

http://www.ehs.berkeley.edu/pubs/factsheets/04electro.pdf

The checklist, can be used to determine whether the electrophoresis units and their power supplies are in safe working condition. The equipment should not be used until all hazards have been safeguarded.
Ethidium bromide is a potent mutagen that has been used for many years as a nucleic acid stain. This material fluoresces a red-orange color under ultraviolet light and with increased fluorescence when bound to double-stranded DNA. Ethidium bromide is typically purchased in powder or solution form and is soluble in water. The crystal or powder form is odorless and appears dark red in color. The powder form is considered an irritant to the upper respiratory tract, eyes, and skin. Ethidium bromide is strongly mutagenic, causing living cell mutations. Even though there is no evidence at this time of human carcinogenicity or teratogenicity, this material should be considered a possible carcinogen or teratogen.

**Personal Protection**

Wear a lab coat, eye protection, and nitrile gloves when working with ethidium bromide. Leave lab coats, gloves, and other PPE in the lab, when your work is complete, to prevent the spread of this or other chemicals outside of the lab.

When an ultraviolet light source is used in your work with ethidium bromide, added caution is required. As a general rule, avoid exposing unprotected skin and eyes to intense UV sources. If the UV light is aimed upwards, wear a UV protective face shield when you are standing near the source. For prolonged work close to UV light boxes or other intense sources, it may be useful to wrap the end of the lab coat sleeves loosely with masking tape to prevent gaps where the wrist could be exposed. When Ethidium Bromide is added to gels it may be useful to add a protective layer of saran wrap on gel box.

**Work Practices**

When working with ethidium bromide, minimize the potential for spills. Where practical, purchase ready-made stock solutions from chemical manufacturers in lieu of mixing your own solutions. If you prefer to mix your own solutions of ethidium bromide, protect yourself by doing this process in a fume hood. Perform all processes that generate ethidium bromide dusts or mists inside the fume hood to minimize inhalation exposures. Prevent accidents by transporting small quantities of ethidium bromide in a secondary container instead of carrying large quantities.

**Spills**

All labs should have a spill kit available. Spills of ethidium bromide solutions should be absorbed and decontaminated with soap and water. Avoid raising dust when cleaning up solid spills by mixing with water and then absorbing the solution. All spill cleanup materials and absorbents should be bagged or placed in a sealed container with a hazardous waste label. Request a waste pickup from EH&S.

Some facilities use a hand held UV lamp to check for residual ethidium bromide contamination following spill cleanup. A reddish-orange fluorescence can be detected under both “long” and “short” UV wavelengths. Users of the hand held lamps should be aware that their ability to detect small spills is not guaranteed. The ease of detection depends upon a variety of factors including the chemical composition of the sample, the wavelength of the UV lamp, and the intensity of the lamp. Use of a hand held UV lamp to detect traces of ethidium bromide may serve as an occasional check of laboratory practices, but it cannot substitute for good cleanliness and careful contamination control.

**Waste Disposal**

All ethidium bromide waste must be disposed of according to UCSB hazardous waste disposal procedures. Website is [http://ehs.ucsb.edu](http://ehs.ucsb.edu). Under Programs select Hazardous Waste.
Long-term exposure to formaldehyde (HCHO) puts you at increased risk of developing cancer. Short-term exposure – even at very low concentrations - can cause severe irritation to the eyes, skin and respiratory tract. Formaldehyde is a highly toxic and flammable gas with a strong pungent odor. However, it is most commonly used as an aqueous solution (formalin) which often also contains some methanol. It is commonly used in tissue fixing and preservation, disinfection and as an organic chemical reagent.

It is one of the few chemicals with a specific regulatory standard written to protect workers. Cal-OSHA permissible exposures levels for formaldehyde are very low and violations of the standard can result in heavy fines. It is the responsibility of the lab supervisor/PI to ensure that all legally-required protections are in place and understood by their workers. EH&S periodically evaluates potential formaldehyde exposures for campus labs.

**Exposure Hazards of Formaldehyde**

**Short-Term Effects of Exposure**

- **Inhalation** – formaldehyde is highly volatile and inhalation is therefore a major route of exposure. Above 0.1ppm it can irritate the nose, throat and lungs, but its odor threshold is higher – about 1 ppm. Therefore, lack of odor cannot be used as an indicator of safety. Above 25 ppm it can cause severe injury, including pulmonary edema (water in the lungs).

- **Skin contact** – causes skin irritation and in some individuals an allergic dermatitis (rash)

- **Eye contact** – eyes are particularly vulnerable to formaldehyde and above about 2 ppm, it is quickly irritating. Above 20 ppm can cause permanent clouding of the cornea.

**Long-Term Effects of Exposure**

Formaldehyde has been shown to cause cancer in lab animals and can cause cancer in humans. It is listed as a known human carcinogen by the International Agency on Research of Cancer and the National Toxicology Program.

**Cal-OSHA Legal Limits for Exposure**

- **Permissible Exposure Limit (inhalation):** 0.75 ppm (8 hr time-weighted average)
- **Short-term Exposure Limit (inhalation):** 2 ppm (15 minutes)
- **Action Level (inhalation):** 0.5 ppm

If EH&S suspects your exposure to formaldehyde may exceed these levels, UCSB must monitor your exposure level. If you work with formaldehyde outside of a fume hood, or glove box it is likely that your exposure is above-limits. If monitoring confirms that your exposure is above-limits, then a medical surveillance program must be made available to you at no cost.
Controlling Exposures

Engineering Controls
Given its volatility and toxicity, formaldehyde should only be used in a fume hood or glove box. Breathing HCHO fumes is not acceptable.

Protective Clothing and Equipment

- **Skin protection** – gloves must be worn whenever formalin, or tissues preserved/fixed with formalin, are handled. Medium or heavyweight nitrile, neoprene, natural rubber, or PVC gloves should be worn when handling. Disposable (exam) nitrile gloves may be used when handling dilute concentrations (10% or less). Use of a lab coat is strongly recommended.

- **Eyewear** – given the severe effect of formaldehyde on the eye, normal safety glasses are not recommended for procedures with splash potential. Instead, wear chemical goggles or a face shield when handling formaldehyde to minimize the risk of even a small splash or vapor exposure to the eyes.

- **Respirator** – if a fume hood is used, then a respirator is not needed. If a respirator is needed for special circumstances, you must first contact EH&S (x-8787) to enter the UCSB Respiratory Protection Program to satisfy OSHA requirements.

Other Issues

- **Material Safety Data Sheets (MSDS)** - Per Cal-OSHA, formaldehyde users must know what MSDS are, their relevance to health and safety and how to readily access them. These issues are all covered in the EH&S Lab Safety Orientation. Regular users of formaldehyde should have a hard copy MSDS available - see the EH&S website for electronic MSDS access.

- **Chemical Hygiene Plan** – Per Cal-OSHA, formaldehyde/formalin is considered a Particularly Hazardous Substance. Therefore, its safe use must be addressed in a laboratory’s written Chemical Hygiene Plan (CHP). Since many safety issues are addressed generically in this document, it can be used as a resource in developing your CHP. Lab supervisors/PIs should contact EH&S at x-4899 if you need an orientation to this requirement.

- **Flammability** - Formalin is not a significant fire risk. Formaldehyde gas is highly flammable.

- **Chemical Compatibility** - See Material Safety Data Sheet

- **First Aid** - For skin and eye contact, use the lab emergency shower/eyewash to immediately flush with plenty of water for at least 15 minutes. Remove contaminated clothing. For serious inhalations, immediately move the person to fresh air and call 9-911 for immediate medical attention.

- **Spill, Leak and Disposal** - Place leaking containers in a fume hood. If it can be done safely, clean-up small spills with absorbent material – available in many buildings “spill closet”. For larger spills, leave the area and contact EH&S at x-3194. Like other chemical wastes, all formaldehyde wastes should be disposed of through EH&S. Sink disposal is not legal.

Footnotes:
1. Example: Columbia University was fined $77,000 in 1999 for violations of the OSHA formaldehyde standard.
Laboratory Safety Fact Sheet #2
Fume Hood Usage Guidelines

By following a few simple guidelines, the effectiveness of your fume hood can be increased significantly and your exposure to harmful substances can be reduced.

1. **Always work with the sash at the level of the arrow sticker and close it when not attended.** To adequately protect you, your hood should be producing a face velocity of 100 to 120 ft/min. EH&S tests your hood and posts the arrow stickers at the proper sash level to:
   - Satisfy the required air flow and protect you (10-100 times more than full open sash) against airborne chemicals
   - Protect you better from incidents within the hood

2. Many newer hoods on campus are equipped with an 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.** Do **NOT** disengage or over-ride the alarm. If your alarm sounds consistently this indicates a real problem - call EH&S at the below phone number right away.

3. **Store only the bare 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 and reduce performance significantly. Permanent equipment should be raised on a jack and kept at least 6" inside the hood to allow the air to flow into the lower slot.
   - Chemicals should not be stored in the fume hood - most fires and explosions occur in the hood during chemical manipulations. Minimizing the volumes will reduce the chances of a small accident escalating into a large one.

4. **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 velocity)

For further information contact the EH&S Laboratory Safety Specialist at x-4899 or consult the *UCSB Laboratory Safety Program with Chemical Hygiene Plan* Rev. 7/97
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)**
**Lab Coats for Working with Flammable Liquids and Pyrophorics**

**Proper Cleaning of Lab Coats**

**Introduction/Purpose:** Lab coats can serve a number of purposes – protection from chemical splash, fire resistance, clothing protection, or just to look like a scientist! There are a wide variety of lab coats available. This document is not intended to be a comprehensive look at lab coats – if you want more information, check with a coat vendor, or a good Website is: [http://www.labcoatsreview.com](http://www.labcoatsreview.com) The primary purpose of this document is to focus on the **types of lab coats for working with flammable solvents or pyrophorics** (spontaneously combustible) in the lab. In 2009, a young woman researcher using a pyrophoric liquid at UCLA was killed when her synthetic sweater caught fire – she was not wearing a lab coat. The related issue of proper laundering of lab coats is also addressed herein.

**Use of Lab Coats**

It is strongly recommended that those labs using pyrophorics, flammable liquids and skin-contact hazardous materials¹, e.g., acid/bases, toxics, make it their policy to:

- always wear a lab coat when handling these reagents
- have available one or more fire-resistant lab coats per below
- these policies should be formally incorporated into the lab’s OSHA-complaint *Chemical Hygiene Plan* and shared with all workers

**Lab Coats and Fire-resistance** (in rough order of decreasing fire resistance)

1. **Nomex** - offers the highest level of lab coat protection from fire. Highly fire-resistant because the fabric thickens, carbonizes and remains intact under fire conditions. Used widely in occupations where fire is a real hazard. **Other Advantages:** strong, flexible, good resistance to tearing, resistant to most solvents and to acids and alkalis, can be cleaned at home or commercially. **Disadvantages:** Nomex decomposes if exposed to chlorine bleach; can be hot in certain situations (e.g., outdoors); more expensive

2. **Fire-resistant cotton** - cotton coats are available that are treated with a fire-resistant material. However, this capability may dissipate after repeated laundering. Mid-way in price between untreated cotton and Nomex.

3. **100% Cotton** - superior to synthetic blends for fire-resistance, but inferior to those above. **Advantages:** comfortable, cheaper than coats above. **Disadvantages:** rarely last more than a year with daily use; can be degraded by acids

4. **Synthetic/Cotton Blends** - 100% polyester coats, or cotton/polyester blends are the most combustible and are not considered appropriate for working with flammables. Blended coats are currently carried in the Biology storeroom and campus bookstore.
Some Coat Vendors: Fisher Scientific (under UC contract), Mission Linen Supply (local, under UC contract, phone number below), Lab Safety Supply Co.

Laundry Services for Lab Coats
Laundering a contaminated coat at home is not desirable. There are two lab coat laundering services available in the Santa Barbara area: Mission Linen Supply (800-944-5539) and Aramark (736-7551). They will pick up your coats on an agreed-to frequency and return them clean to the lab. These services are not expensive. Also, as noted above, bleaching will degrade Nomex and Fire-resistant cotton coats. So, specify no bleach with these laundering services.

Footnotes: 1. A chemically-resistant apron should provide better skin protection than a lab coat for corrosives and other skin-contact hazards. 2. Although harder to find, a lab coat with snaps instead of buttons would be easier to remove in a fire situation.
Phenol (carbolic acid) is a colorless or pink crystalline solid or viscous liquid with a characteristic sweet, tarry odor. It can affect the body if it is inhaled, ingested, or contacts eyes or skin.

**Hazards With Acute Exposure**

- Contact with eyes may cause severe damage and blindness.
- Contact with skin may cause severe burns or systemic poisoning.
- Systemic effects may occur from any route of exposure, especially after skin absorption.

**Hazards With Chronic Exposure**

- Repeated or prolonged skin exposure to phenol or vapors from heated phenol may cause headache, nausea, dizziness, diarrhea, vomiting, shock, convulsions, and death.

- Phenol affects the central nervous system, liver, and kidneys.

**Special Safety Precautions**

- Phenol should be used with adequate ventilation to minimize inhalation. When heating phenol, use a water bath inside a chemical fume hood. **NEVER** heat or melt phenol in an incubator, microwave, drying oven, or similar appliance.

- Prevent contact with skin by wearing neoprene gloves, lab coat, and resistant apron.

- Wear safety glasses or a face shield if splashing may occur.

- Store in a cool, dry, well-ventilated area, away from heated surfaces or ignition sources.

- Skin contact requires immediate washing of the affected area with soap and water. Remove contaminated clothing and launder before wearing again.

- When phenol is heated, it can react vigorously with oxidizing agents.

- Phenol waste should be placed in a properly labeled glass bottle with a securely sealed lid.

- **Spills of undiluted phenol should be considered serious and cleaned up immediately.** Small liquid spills of 50 ml or less may be absorbed using paper towels, vermiculite, or other absorbent and placed in a sealed container or double plastic bags. If the spill is larger than 50 ml, remove ignition sources, provide adequate ventilation, evacuate the laboratory, close the doors, and call EH&S at x-3194.

*For further information, contact the EH&S Laboratory Safety Specialist at x-4899*
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.
**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 #5
Refrigerators & Freezers in Lab

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 an 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).

This picture shows a UCI lab refrigerator which exploded when chemicals were inappropriately stored in a unit which was not designed for flammables storage.

For further information contact EH&S Laboratory Safety Specialist at X4899
Campus Guideline:
Refrigerators in Chemical-using Laboratories

The safe storage of chemicals in laboratory refrigerators is often an area of controversy. Specifically, when researchers state that they have no intention of storing any "flammable chemicals" in a proposed new unit and therefore do not wish to pay the extra cost for an approved "flammable storage" unit. However, as delineated in more detail in the attached excerpts from the CRC Handbook of Laboratory Safety, these honest intentions are undercut by other facts:

- If a flammable liquid is placed in a normal (household) refrigerator there is a reasonable chance of a powerful explosion that would cause serious injuries or fatalities. Such instances are documented – see attached picture from explosion at UCI.

- Refrigerators can last up to 30 years, and therefore, no one can assure that they will never be misused, particularly with the constantly changing research and personnel of an academic lab. Nor can anyone assure that a given unit will even stay within the same group or lab for its lifetime.

- It is not reasonable to rely on warning signage to assure that refrigerators will never be misused. Signs are often not read, misunderstood, damaged or ignored.

*Therefore, it is the strong recommendation of the campus Chemical Safety Committee that the following guidelines be adhered to by PIs and departments when new refrigerators are obtained for their areas employing chemicals. Environmental Health & Safety monitors refrigerators when ordered and during periodic lab inspections.*

1. If there is one, or more, existing approved flammable storage refrigerators within a given lab, or suite of adjacent PI labs, then new units do not necessarily have to be the flammable storage type – unless the unit is specifically planned for such use.

2. If a proposed unit is the sole refrigerator present, and if flammable/combustible liquids are used or stored within the room that the refrigerator will occupy, then it should be of the approved flammables storage type.

3. All refrigerators in chemical-using areas must be clearly labeled with directions as to what materials can, and can not, be safely stored there.

4. The modification of domestic refrigerators ("desparking") to convert them to chemical use is prohibited on campus and is illegal.

5. The committee requests that EH&S enforce these guidelines whenever feasible, but also use their professional judgement when appropriate to make exceptions in unusual situations.

_Signed_

Stan Parsons
Chair, Chemical Safety Committee
Laboratory Refrigerators

Excerpts from: CRC Handbook of Laboratory Safety, 4th ed., Section 4.5.7

“..... the most dangerous storage units in any laboratory is the ordinary refrigerator..... This is primarily due to the storage of flammable materials within them...... The flash points of many common lab solvents are below or close to the normal operating (about 38° F) of a common refrigerator. Most of these evaporate rapidly so that they quickly reach equilibrium concentrations in a closed space.

Carelessly closed containers, e.g. screw caps that are not firmly tightened or beakers containing solvents covered only with aluminum foil or plastic wrap, will allow vapors to escape from the container and, given sufficient time, build up in the confined space until they reach a concentration in excess of the lower flammability limit. A spark may then cause ignition, and because the reaction is temporarily constrained, very high pressures can build up until the refrigerator door latch fails and a powerful explosion ensues. Many such cases have been documented, and in most cases, workers in the vicinity in front of the refrigeration unit likely would have sustained serious if not fatal injuries.

A normal refrigerator has many sources of ignition – the thermostat, interior light, the light switch on the door, the defrost heater, the defrost control switch, the compressor unit, and the fan. Most of these are located within the space being maintained cool, but self-defrosting units contain an internal drain that can permit internal vapors to flow into the compressor space below....

Refrigerators can last for as many as 20 to even 30 years. It is not feasible to accept assurances by laboratory managerial personnel that no flammable materials will ever be placed in an ordinary refrigerator, because neither the individual making the promise nor the program for which the refrigerator is purchased is likely to occupy the same laboratory space for such an extended period. It is also not reasonable to depend upon marking laboratory refrigerators, no matter how prominently, as not to be used for flammable material storage and count on compliance with the restriction. If there is an ordinary consumer-quality refrigerator in the laboratory, it is virtually certain that someone will eventually use it improperly. Therefore, it is recommended that all refrigerators to be used in laboratory areas be required to be initially constructed for flammable material storage, and bear an appropriate label on the front that it meets such standards.”
UCI Explosion Picture
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

*For further information contact the EH&Sx-4899*
Sharps are defined as any object having acute corners, edges or protuberances capable of cutting or piercing, e.g. syringe needles, razor blades, glass, etc. These items **cannot be disposed of in the normal lab trash**. Every year custodians are injured by sharps in trash cans. Therefore, please follow these guidelines:

1. **Lab glassware not contaminated by hazardous materials (e.g. Pasteur pipettes)**
   Place glass into a labeled “Sharps Only” trash box or other sturdy container. Cardboard boxes specifically made and labeled for this purpose are available from scientific supply companies, or in most campus storerooms. When full, dispose of contents into the trash dumpster for your building - the custodial staff will **not** empty these.

2. **Needles and razor blades not contaminated by hazardous materials**
   These are particularly dangerous and require precautions beyond those of glassware:
   - Label a **rigid puncture-proof container** with the words “Sharps Waste” (note cardboard is not acceptable)
   - Place all sharps into sharps container as they are generated
   - When full, tape container closed or tightly lid containers prior to disposal
   - Place sealed sharps containers directly into bldg. dumpster, or into the glass container noted above

3. **Sharps contaminated by hazardous materials**
   If sharps are uncontaminated use the procedures above. For contaminated sharps follow the additional procedures here:
   - **Sharps contaminated with chemicals** - A sharps container as described above should be labeled as “Sharps contaminated with (chemical name)”. Give to EH&S for disposal with other chemical wastes.
   - **Sharps contaminated with radioactive materials** - A sharps container as described above should be properly labeled as “Sharps contaminated with (isotope name)”. Give to EH&S for disposal.
   - **Sharps contaminated with biohazardous (infectious) materials** - Sharps contaminated by biohazardous materials must be placed in approved red plastic sharps container (available in Biological Sciences Storeroom). The sealed containers must be autoclaved before disposal and within 7 days of becoming filled. Place autoclaved container in an opaque bag and place into dumpster, or glass container noted above.

For further information contact the EH&S Laboratory Safety Specialist at x-4899.
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.
Appendix B: Chemical Resistance of Common Lab Gloves

This appendix reproduces tables of the chemical resistance data for gloves available at UCSB store rooms (accessed via http://ehs.ucsb.edu/units/labsfty/labrsclsglove.htm on 8/13/14)
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Choose Your Gloves Wisely

### Biology

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* Barrier gloves are available in the Physics storeroom

The below values are an average of the above chemicals of that type and can be used for other generic chemicals of that type

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Choose Your Gloves Wisely

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* Barrier gloves are available in the Physics storeroom

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Visit the EH&S website for more details: http://ehs.ucsb.edu/
Choose Your Gloves Wisely

## Physics

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<th>Dermathin</th>
<th>Neoprene</th>
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A blank value means that glove has not been tested with that chemical

The below values are an average of the above chemicals of that type and can be used for other generic chemicals of that type

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Visit the EH&S website for more details: [http://ehs.ucsc.edu/](http://ehs.ucsc.edu/)  
Revised 3/6/2012
Appendix C: MRL Emergency Operations Plan

This appendix reproduces the MRL Emergency Operations Plan (also Emergency Action Plan & Fire Prevention Plan), accessed on 8/13/14 via

http://www.mrl.ucsb.edu/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
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 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 55¢. 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 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
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

Emergency Assembly Point (EAP) is shown marked with a star.

PSB South
Physics
Engineering I
MRL
Engineering II
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
EMERGENCY EXIT PLAN
MRL THIRD 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

Appendix C 8/8 KE, Rev. 8/18/14
Appendix D: MRL Combined Injury & Illness Prevention Plan and Hazard Communication Plan

This appendix reproduces the MRL Combined Injury & Illness Prevention Plan and Hazard Communication Plan, accessed on 9/18/09 via

http://www.mrl.ucsb.edu/mrl-injury-illness-prevention-plan

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

Prepared by Joe Doyle

This document is formally adopted by the Materials Research Laboratory.

Dr. Philip Pincus
Acting Director
January 20, 1998

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. Craig Hawker
- Acting Director: Dr. Philip Pincus
- 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: Joe Sachleben
- 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.

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 an 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.**

**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:

8. Name of the contents in written English, chemical symbols are not enough

9. Appropriate hazard warnings

10. The name of the person who purchased or uses the chemical

11. 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.
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Appendix E: Laboratory Self-Inspection Checklist

This appendix contains the EH&S Laboratory Self-Inspection Checklist, accessed on 08/15/14 via

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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](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 designated to empty these into their bldg. red-lidded trash can – custodial staff will not do so.
1. Is your lab’s legally-required (Cal-OSHA) Lab-specific Chemical Hygiene Plan (CHP) 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)

4. Are stored chemicals segregated according to hazard classification/compatibility (acids, bases, flammables, oxidizers, water reactives, 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. 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 containers/equipment involved in pumping flammable liquids to prevent buildup of static electricity as an ignition source.

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

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

9. 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.
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 EH&S 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 ("**hydostatic testing**") **Check stamped date on cylinder when it was last tested.**
   - Corrosive gases (e.g. **HF, HBr, HCl, H_2S**) 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 arrestor** to prevent flame flashback to cylinder. Available from gas vendors.
   - Use of large cylinders of **highly toxic gases** must be reviewed/approved (contact EH&S, 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. 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?**”
   - Laboratory refrigerators/freezers and other sensitive equipment, preferably should be connected to emergency back-up power.
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 out 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.

### 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?
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.

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

10. Is the level of housekeeping in the lab satisfactory?
    - No hazardous materials stored on floor
    - Aisles, secondary exits and corridors kept clear
    - Lack of clutter
    - Glassware that is scattered on benchtops 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.

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

   - □ 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 Automated External Defibrillator (AED), available in some departments?
   - □ The location of the circuit breaker box?
   - □ The location/purpose of your building’s Safety Corner bulletin board?
   - □ The identity of your Department Safety Rep?
   - □ The availability/purpose of the UCSB Hazard Reporting Form?

   Any questions, please call X-8243.
Appendix F: LHAT assessments for the Safinya Labs

This appendix contains the certified, LHAT-generated laboratory hazard assessments for the three Safinya labs, accessed on 8/13/14 via

https://ehs.ucop.edu/lhat/
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Lab Menu: / Edit Lab (.../lab/identifyLab.htm?labId=2159) / Assessment
/ Roster (.../lab/roster.htm?labId=2159) / Invite List (.../lab/inviteLabWorker.htm?labId=2159)

**Laboratory Hazard Assessment: Main MRL labs**

In this section, the PI or Responsible Person will:
- Conduct a hazard assessment of the laboratory group to identify activities when PPE is needed to protect laboratory personnel.
- Certify the hazard assessment for the laboratory.

The LHAT is a PPE selection tool only; administrative and engineering controls for specific activities are contained in your laboratory-specific Standard Operating Procedures (SOPs). For activities that are described in a laboratory-specific SOP or for activities where a Use Authorization (UA) has been issued by a campus safety committee, the PPE specified in that SOP/UA shall take precedence.

**Pl or Responsible Person:** Cyrus Safinya  
**Primary Appointment:** MATERIALS DEPARTMENT

**Phone:** 805-893-8635  
**Email:** safinya@mrl.ucsb.edu

**Laboratory Phone:** 805-893-4859

**Laboratory Locations:**

- Materials Research Lab First Floor 1012B
- Materials Research Lab First Floor 1012
- Materials Research Lab First Floor 1024
- Materials Research Lab First Floor 1032

All sections are required. A Hazard Assessment can be saved as a draft to be completed and certified at a later time. The final assessment report will summarize the PPE applicable for the hazards identified in the laboratory. Once a Hazard Assessment has been certified, it can only be altered by amending the assessment. All answers to standard and lab specific questions will be retained permanently.

<table>
<thead>
<tr>
<th>Section</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Laboratories</td>
<td>Complete</td>
</tr>
<tr>
<td>Chemical Hazards</td>
<td>Complete</td>
</tr>
<tr>
<td>Physical Hazards</td>
<td>Complete</td>
</tr>
<tr>
<td>Biological Hazards</td>
<td>Complete</td>
</tr>
<tr>
<td>Radiological Hazards</td>
<td>Complete</td>
</tr>
<tr>
<td>Laser Hazards</td>
<td>Complete</td>
</tr>
<tr>
<td>Non-Ionizing Hazards</td>
<td>Complete</td>
</tr>
</tbody>
</table>
Custom Laboratory Activities - Optional

Recommended PPE - Viewable after the assessment has been certified

<table>
<thead>
<tr>
<th>Personal Protective Equipment</th>
<th>Custom Laboratory Activity PPE</th>
<th>Shared Protective Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Closed toe/heel shoes</td>
<td>• Flame-resistant (FR) outer gloves</td>
<td></td>
</tr>
<tr>
<td>• Full-length pants or equivalent</td>
<td>• Chemical-resistant apron</td>
<td></td>
</tr>
<tr>
<td>• Chemical splash goggles</td>
<td>• Face shield</td>
<td></td>
</tr>
<tr>
<td>• Safety glasses</td>
<td>• Disposable gloves</td>
<td></td>
</tr>
<tr>
<td>• Lab coat</td>
<td>• Thermal protective gloves (impermeable insulated gloves for liquids and steam)</td>
<td></td>
</tr>
<tr>
<td>• Flame resistant lab coat (NFPA 2112)</td>
<td>• Cryogenic protective gloves</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Shoe covers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Possibly warm clothing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Optical density and wavelength-specific safety glasses based on individual beam parameters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Chemical-resistant gloves</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Cut-resistant gloves</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Impermeable or chemical resistant gloves</td>
<td></td>
</tr>
</tbody>
</table>

Notes:

- It is not allowed to require Laboratory Workers to purchase their PPE. Some PPE will be provided by the campus, and all other PPE must be provided by the individual laboratories.
- In all cases, chemical splash goggles can be substituted for safety glasses and provide a higher level of protection when working with large quantities of material. For splash or impact protection, either chemical splash goggles or safety glasses need to be worn under face shields.
- All chemical spills need careful evaluation for the hazards presented and course of action. "Minor" and "Major" chemical spills might be determined by the quantities of material spilled or the health hazard presented.
Laboratory Hazard Assessment: LOM

In this section, the PI or Responsible Person will:

- Conduct a hazard assessment of the laboratory group to identify activities when PPE is needed to protect laboratory personnel.
- Certify the hazard assessment for the laboratory.

The LHAT is a PPE selection tool only; administrative and engineering controls for specific activities are contained in your laboratory-specific Standard Operating Procedures (SOPs). For activities that are described in a laboratory-specific SOP or for activities where a Use Authorization (UA) has been issued by a campus safety committee, the PPE specified in that SOP/UA shall take precedence.

**Pl or Responsible Person:** Cyrus Safinya  
**Primary Appointment:** MATERIALS DEPARTMENT  
**Phone:** 805-893-8635  
**Email:** safinya@mrl.ucsb.edu  
**Laboratory Phone:**  
**Laboratory Locations:**

Materials Research Lab First Floor 1012A

All sections are required. A Hazard Assessment can be saved as a draft to be completed and certified at a later time. The final assessment report will summarize the PPE applicable for the hazards identified in the laboratory. Once a Hazard Assessment has been certified, it can only be altered by amending the assessment. All answers to standard and lab specific questions will be retained permanently.

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<td>Complete ✓</td>
</tr>
<tr>
<td>Non-Ionizing Hazards</td>
<td>Complete ✓</td>
</tr>
<tr>
<td>Custom Laboratory Activities - Optional</td>
<td></td>
</tr>
<tr>
<td>Recommended PPE - Viewable after the assessment has been certified</td>
<td></td>
</tr>
</tbody>
</table>
No PPE is recommended. This laboratory has been designated and posted as free of chemical, physical, biological, radiological, laser, and non-ionizing hazards.

| Personal Protective Equipment | Custom Laboratory Activity PPE | Shared Protective Equipment |

**Notes:**
- It is not allowed to require Laboratory Workers to purchase their PPE. Some PPE will be provided by the campus, and all other PPE must be provided by the individual laboratories.
- In all cases, chemical splash goggles can be substituted for safety glasses and provide a higher level of protection when working with large quantities of material. For splash or impact protection, either chemical splash goggles or safety glasses need to be worn under face shields.
- All chemical spills need careful evaluation for the hazards presented and course of action. "Minor" and "Major" chemical spills might be determined by the quantities of material spilled or the health hazard presented.
In this section, the PI or Responsible Person will:

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**PI or Responsible Person:** Cyrus Safinya  
**Primary Appointment:** MATERIALS DEPARTMENT  
**Phone:** 805-893-8635  
**Email:** safinya@mrl.ucsb.edu  
**Laboratory Phone:** 805-893-4859  
**Laboratory Locations:** Materials Research Lab First Floor 1016

All sections are required. A Hazard Assessment can be saved as a draft to be completed and certified at a later time. The final assessment report will summarize the PPE applicable for the hazards identified in the laboratory. Once a Hazard Assessment has been certified, it can only be altered by amending the assessment. All answers to standard and lab specific questions will be retained permanently.

+ All Laboratories Complete ✔
+ Chemical Hazards Complete ✔
+ Physical Hazards Complete ✔
+ Biological Hazards Complete ✔
+ Radiological Hazards Complete ✔
+ Laser Hazards Complete ✔
+ Non-Ionizing Hazards Complete ✔
+ Custom Laboratory Activities - Optional
  - Recommended PPE - Viewable after the assessment has been certified
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<th>Shared Protective Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed toe/heel shoes</td>
<td>Face shield</td>
<td>Double layer disposable gloves</td>
</tr>
<tr>
<td>Full-length pants or equivalent</td>
<td>Disposable gloves</td>
<td></td>
</tr>
<tr>
<td>Chemical splash goggles</td>
<td>Eye and mucous membrane protection (as appropriate for operations)</td>
<td></td>
</tr>
<tr>
<td>Safety glasses</td>
<td>Thermal protective gloves (impermeable insulated gloves for liquids and steam)</td>
<td></td>
</tr>
<tr>
<td>Lab coat</td>
<td>Chemical-resistant gloves</td>
<td></td>
</tr>
<tr>
<td>Barrier lab coat impervious to fluids</td>
<td>Cut-resistant gloves</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- It is not allowed to require Laboratory Workers to purchase their PPE. Some PPE will be provided by the campus, and all other PPE must be provided by the individual laboratories.
- In all cases, chemical splash goggles can be substituted for safety glasses and provide a higher level of protection when working with large quantities of material. For splash or impact protection, either chemical splash goggles or safety glasses need to be worn under face shields.
- All chemical spills need careful evaluation for the hazards presented and course of action. "Minor" and "Major" chemical spills might be determined by the quantities of material spilled or the health hazard presented.
This section of the document is now provided to laboratories in an electronic version only – see URL (Web address) provided below.

Web address (URL) for Section II:
http://ehs.ucsb.edu/units/labsfty/labsc/chemistry/CHP%20Pages/Sec.II.2013.pdf

Per Cal-OSHA requirements, this document needs to be reviewed and updated annually. Therefore, please refer to the web version for the most recent update. The hardcopy in this binder is based on the web version from March 2013 (which is the current version on the EH&S website as of August 13, 2014) and is only provided for your convenience, without implying that it is the current version.

Questions can be directed to David.Vandenberg@ehs.ucsb.edu

See also the Table of Contents – UCSB Chemical Hygiene Plan webpage at
http://www.ehs.ucsb.edu/units/labsfty/labsc/chemistry/lschemContentsCHP.htm
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UCSB POLICIES, PROCEDURES AND RESOURCES

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- Fire Extinguishers, First-Aid Kits and Emergency Shower/Eyewashes 5

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Introduction to Section II: UCSB Policies, Procedures and Resources:

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 CHPs, they are provided herein. In Section I the laboratory-specific issues/SOPs for a particular lab must be addressed.

The issues summarized here are 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. Virtually all of the issues addressed herein are based on current regulations and codes, such as those of the California Occupational Safety and Health Administration (Cal-OSHA); Cal-EPA; California Fire Code, etc.

The Cal-OSHA CHP safety standard requires the addressing of chemical? Training? safety issues, but not other laboratory hazards. For example, biological and radiological hazards, electricity, high/low temperature and pressure, etc. Therefore, these issues are largely not addressed here. However, supervisors are free/encouraged to address these issues in their CHP also. A free reference book that addresses many of these issues is: Prudent Practices in the Laboratory, from the National Research Council. This reference is widely recognized as the “bible” of laboratory safety and all researchers are strongly encouraged to bookmark its location, or buy a hardcopy for their areas.

http://www.nap.edu/catalog.php?record_id=12654#toc
Emergency Response Procedures

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. If you want a copy for your work area, contact EH&S at x-4899. A Spanish language version of the flipchart is also 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, AEDs, 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 at: http://www.ehs.ucsb.edu/homepage/hprsc/203655_Emerg_Flipchart.pdf
Recommended Chemical Spill Cleanup Procedures

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 9-911 (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.
- Contain and absorb spill using absorbents appropriate for the material*
- 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 master keys in some buildings: http://www.ehs.ucsb.edu/units/labsfty/labrc/emergency/spillcloset.htm
Fire Extinguishers, First-Aid Kits and Emergency Showers/Eyewashes

Fire Extinguishers: Extinguisher(s) are in every lab – typically by the exit door and are the ABC variety (dry powder, ammonium phosphate). EH&S conducts hands-on fire extinguisher training for most individuals who attend the EH&S General Laboratory Safety class. There is also an online extinguisher tutorial/video that individuals can complete and receive credit. All campus individuals are strongly encouraged to complete this tutorial and view as refresher training when needed.

Online Fire Extinguisher Usage Tutorial:
http://learningcenter.ucsb.edu/default.aspx
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 should also 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.
Campus Policy on Laboratory Personal Protective Equipment (PPE)

In July 2011 UCSB instituted a new policy on the use of personal protective equipment (PPE) in laboratories. The policy is intended to help protect lab workers from injury, meet regulatory requirements for worker protection and bring more consistency to PPE practices across the campus. All members of the lab community have responsibilities under the policy - particularly lab supervisors/faculty and lab workers. Full policy is at:

http://www.policy.ucsb.edu/policies/policy-docs/lab-personal-protective-equip.pdf

Key aspects of the policy are summarized on a wall poster which is mounted in all labs, or lab suites. A copy of the poster is presented on the following page. Other notable aspects of the policy are noted here, but the full policy should be consulted for details:

- The PPE requirements only apply when “handling” hazardous materials, not when an individual is simply in the same room with materials.

- Radiological and biological hazards are not covered by the policy. Instead, PPE for these is regulated by the Radiation and Biosafety Committees, respectively.

- Lab gloves must not be worn in public areas unless traveling to an adjacent lab space, or needed for protection while transporting materials between work areas – in which case clean gloves should be donned.

- Safety eyewear must meet American National Standards Institute (ANSI) requirements. This is denoted by the “Z87” stamp on the eyewear. Most reading glasses do not meet ANSI standards. Approved safety glasses can be worn over contact lenses, or splash goggles can be worn over reading glasses, or one can obtain prescription safety glasses.

- Contaminated lab coats should not be laundered at home. Some campus labs use a local vendor to provide routine lab coat laundering services. The service is inexpensive. See:
  http://www.ehs.ucsb.edu/units/labsfty/labrsc/factsheets/Lab_Coats_FS35.pdf
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>** CATEGORY 1: Significantly Hazardous Chemicals **</td>
<td>EXAMPLES:&lt;br&gt;• Corrosives (above 5% by weight acids/bases)&lt;br&gt;• Flammables/Combustibles above one liter&lt;br&gt;• Materials Absorbed Through Skin&lt;br&gt;• Skin and Eye Irritants&lt;br&gt;• High-Toxics and Neurotoxins&lt;br&gt;• Strong Air or Water Reactives, e.g. Pyrophorics&lt;br&gt;• Strong Oxidizing Agents&lt;br&gt;• Carcinogens and Reproductive Toxins</td>
</tr>
<tr>
<td>** CATEGORY 2: Hazardous Chemicals Not in Category 1 **</td>
<td>EXAMPLES:&lt;br&gt;• Dilute Corrosives (below 5% by wt. acids/bases)&lt;br&gt;• Flammables/Combustibles less than one liter&lt;br&gt;• Liquid Cryogens (LI, solvent/dry ice baths)</td>
</tr>
<tr>
<td>** CATEGORY 3: Selected Physical Hazards **</td>
<td>EXAMPLES:&lt;br&gt;• Glassware under vacuum&lt;br&gt;• Vessels under pressure&lt;br&gt;• Mechanical hazards&lt;br&gt;• Hazardous chemicals not in Category 1,2</td>
</tr>
</tbody>
</table>

** MINIMUM PERSONAL PROTECTIVE EQUIPMENT REQUIRED **

- **ANSI Approved Safety Eyewear**
  - **YES**

- **Appropriate Laboratory Gloves**
  - **YES**

- **Lab Coat, or Fire-Resistant Lab Coat**
  - **YES** (for flammables use fire-resistant coat)

- **Close-toed Shoes and Long Pants**
  - **YES**

---

**Footnotes**

- a. Most American National Standards Institute standards as indicated by “Z87” stamp on frame. Most Hearing glasses do not meet this standard. Eyewear in campus science labs must ANSI standards, as do prescription safety glasses from ophthalmoco.
- b. Consult container label or MSDS to verify “chemical hazard class(es).” Definitions and specific chemical examples are provided in the full policy.
- c. Consult container label, SDS, or a Glove Reference Chart to determine appropriate glove. Glove charts are available via the EH&S Website and other sites.
- d. Definition of “dilute corrosive” as below 5% by weight is only for purposes of this Policy. Corrosives can have other properties requiring gloves at any concentration, e.g., HF acid is particularly penetrative/damaging to skin.
- e. While handling flammable liquids (particularly pyrophorics), it is strongly recommended that synthetic clothing not be worn which is more ignitable than cotton.

**Additional Policy Elements**

- Lab gloves should not be worn in public areas except where clearly needed for personal protection, e.g., during transportation of some particularly hazardous materials.
- PPE for infectious biological agents and radioactive materials are not covered by this Policy. They are regulated independently by the campus Biosafety and Radiation Safety Committees, respectively.
Campus Storerooms: Laboratory Personal Protective Equipment

You can buy supplies from any campus storeroom after establishing an account. The supplies noted below are only the basic PPE available. There are many more materials, styles and brands of PPE available thru safety products suppliers (e.g., Fisher Scientific and Lab Safety Supply).

**Biological Sciences Storeroom, Bldg. 569, x-2537 or 3234**
- Gloves - Nitrile; Latex (powdered); Vinyl examination; Wash gloves (Playtex); High/low temperature
- Eyewear - Goggles; Glasses; Goggles that fit over reading glasses
- Lab coats - Cotton (fire-resistant)
- Sharps disposal - Syringe/razor size; Broken glass box
- Waste disposal bags - Autoclaveable; Biohazard; Hazardous materials
- First aid supplies - Bandaids; Cotton

**Chemistry Storeroom, room 1432, x-2563**
- Lab Coats - Cotton (fire-resistant)
- Gloves - Nitrile; Latex; "Wash gloves"; Cleanroom glove (triple polymer)
- Eyewear – Safety Glasses; Goggles that fit over reading glasses
- Sharps disposal - Syringe/razor size
- First aid supplies - Bandages; Gauze pads; Burn cream

**Physics Storeroom, Broida Hall, room 1301, x-2747**
- Lab Coats - Cotton (fire-resistant)
- Gloves - Nitrile; Neoprene; Latex; Vinyl; Wash gloves (Playtex); Canvas; Leather; Nylon; Finger cots (latex)
- Eyewear - Goggles; Goggles that fit over reading glasses; Glasses w/ side shields; "Neon"-colored glasses; "Malibu" glasses (wraparound)
- Respirator - Dust mask
- Ear plugs - foam type
- Sharps disposal - Broken glass box
- Waste disposal - Glass and plastic 1-gallon containers
- First aid - Bandaids

**University Center Bookstore, x-3271**
- Eyewear - Goggles; Glasses
- Lab coats – Cotton/polyester
Respiratory Protection

Typically, respiratory protection is not needed in a laboratory to eliminate exposures, or keep exposure levels below OSHA Permissible Exposure Limits. Under most circumstances, safe work practices, small scale usage, and engineering controls (fume hoods, biosafety cabinets, and general ventilation) adequately protect laboratory workers from chemical and biological hazards. Under certain circumstances, however, respiratory protection may be needed as determined by EH&S. These can include:

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

Affected individuals must enroll in the UCSB Respiratory Protection Program which is designed to fully meet Cal-OSHA requirements (CCR, Title 8, 5144). Because there are numerous types of respirators available, and each has specific limitations and applications, respirator selection and use requires pre-approval by EH&S. For either required or voluntary use of a respirator, the worker must contact EH&S (x-8787, or x-3743). After an evaluation of the work situation, if a respirator is deemed necessary, EH&S will provide the required medical evaluation (questionnaire), training and quantitative fit-testing.
Selecting the Proper Gloves

The correct gloves protect the hands against chemicals; the wrong gloves enhance chemical contact. The type of glove used should be chosen to be compatible with the particular chemicals being used. **There is no universal glove that protects you from all chemicals. To choose the correct glove, go to a Glove Reference Chart.** (links below).

**Disposable gloves** provide minimal protection and should be used with this in mind. 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.

Check gloves before use for signs of wear or penetration. Disposable gloves can be inflated by mouth 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 the lab.

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 contaminated gloves.

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

[Microflex](http://www.microflex.com/Products/~/media/Files/Literature/Microflex%20Chemical%20Resistance%20Guide.ashx)

[Best Co.](http://www.bestglove.com/site/chemrest/default.aspx)

[MAPA Professionals](http://www.mapaglove.com/ChemicalSearch.cfm?id=0)
Below are airborne chemical concentration limits above which you cannot legally be exposed at work. These limits are administered by the California Occupational Safety and Health Administration (Cal-OSHA). The materials listed here are a fraction of the total number (500+) of OSHA exposure limits – for the complete list, see: [http://www.dir.ca.gov/Title8/5155table_ac1.html](http://www.dir.ca.gov/Title8/5155table_ac1.html). If workers have reason to believe they might be exposed to any hazardous materials, contact EH&S, x-4899, or x-8243. All workers should strive to maintain their chemical exposures as low as reasonably achievable at all times, regardless of the legal exposure limits. Given the volatility of these materials, they should always be used in a properly functioning fume hood, or glove box, or in completely-sealed systems. The “S” notation indicates material is also readily skin absorbed.

<table>
<thead>
<tr>
<th>Chemical Abstracts Registry Number</th>
<th>Skin</th>
<th>Name</th>
<th>Permissible Exposure Limit (ppm)</th>
<th>Short-term Exposure Limit (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>64197</td>
<td></td>
<td>Acetic acid</td>
<td>10 ppm</td>
<td>15 ppm</td>
</tr>
<tr>
<td>67641</td>
<td></td>
<td>Acetone</td>
<td>500 ppm</td>
<td>750 ppm</td>
</tr>
<tr>
<td>75058</td>
<td>S</td>
<td>Acetonitrile</td>
<td>40 ppm</td>
<td>60 ppm</td>
</tr>
<tr>
<td>79061</td>
<td>S</td>
<td>Acrylamide</td>
<td>--</td>
<td>0.03 ppm</td>
</tr>
<tr>
<td>7664419</td>
<td></td>
<td>Ammonia</td>
<td>25 ppm</td>
<td>35 ppm</td>
</tr>
<tr>
<td>62533</td>
<td>S</td>
<td>Aniline</td>
<td>2 ppm</td>
<td>7.6 ppm</td>
</tr>
<tr>
<td>7440371</td>
<td></td>
<td>Argon</td>
<td>--</td>
<td>0.01 ppm</td>
</tr>
<tr>
<td>71432</td>
<td>S</td>
<td>Benzene</td>
<td>1 ppm</td>
<td>5 ppm</td>
</tr>
<tr>
<td>7726956</td>
<td></td>
<td>Bromine</td>
<td>0.1 ppm</td>
<td>C</td>
</tr>
<tr>
<td>7440439</td>
<td></td>
<td>Cadmium metal dust, as Cd</td>
<td>0.005 ppm</td>
<td>--</td>
</tr>
<tr>
<td>630080</td>
<td></td>
<td>Carbon monoxide</td>
<td>25 ppm</td>
<td>200 ppm</td>
</tr>
<tr>
<td>7782505</td>
<td></td>
<td>Chlorine</td>
<td>0.5 ppm</td>
<td>1 ppm</td>
</tr>
<tr>
<td>67663</td>
<td></td>
<td>Chloroform; trichloromethane</td>
<td>2 ppm</td>
<td>9.78 ppm</td>
</tr>
<tr>
<td>110827</td>
<td></td>
<td>Cyclohexane</td>
<td>300 ppm</td>
<td>1,050 ppm</td>
</tr>
<tr>
<td>287923</td>
<td></td>
<td>Cyclopentane</td>
<td>600 ppm</td>
<td>1,720 ppm</td>
</tr>
<tr>
<td>75343</td>
<td></td>
<td>1,1-Dichloroethane</td>
<td>100 ppm</td>
<td>400 ppm</td>
</tr>
<tr>
<td>68122</td>
<td>S</td>
<td>Dimethylformamide; DMF</td>
<td>10 ppm</td>
<td>30 ppm</td>
</tr>
<tr>
<td>74840</td>
<td></td>
<td>Ethane</td>
<td>(h)</td>
<td>--</td>
</tr>
<tr>
<td>141786</td>
<td></td>
<td>Ethyl acetate</td>
<td>400 ppm</td>
<td>1,400 ppm</td>
</tr>
<tr>
<td>64175</td>
<td></td>
<td>Ethyl alcohol; ethanol</td>
<td>1,000 ppm</td>
<td>1,900 ppm</td>
</tr>
<tr>
<td>74851</td>
<td></td>
<td>Ethylene</td>
<td>(h)</td>
<td>--</td>
</tr>
<tr>
<td>60297</td>
<td></td>
<td>Ethyl ether</td>
<td>400 ppm</td>
<td>1,200 ppm</td>
</tr>
<tr>
<td>50000</td>
<td></td>
<td>Formaldehyde</td>
<td>0.75 ppm</td>
<td>2 ppm</td>
</tr>
<tr>
<td>75127</td>
<td>S</td>
<td>Formamide</td>
<td>10 ppm</td>
<td>18 ppm</td>
</tr>
<tr>
<td>64186</td>
<td></td>
<td>Formic acid</td>
<td>5 ppm</td>
<td>9 ppm</td>
</tr>
<tr>
<td>7440597</td>
<td></td>
<td>Helium</td>
<td>(h)</td>
<td>--</td>
</tr>
<tr>
<td>142825</td>
<td></td>
<td>n-Heptane</td>
<td>400 ppm</td>
<td>1,600 ppm</td>
</tr>
<tr>
<td>110543</td>
<td>S</td>
<td>n-Hexane</td>
<td>50 ppm</td>
<td>180 ppm</td>
</tr>
<tr>
<td>CAS Number</td>
<td>Chemical Name</td>
<td>Footnotes</td>
<td>Concentration Limits</td>
<td></td>
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<tr>
<td>------------</td>
<td>---------------------------------------</td>
<td>-----------</td>
<td>----------------------</td>
<td></td>
</tr>
<tr>
<td>1333740</td>
<td>Hydrogen</td>
<td>(h)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10035106</td>
<td>Hydrogen bromide</td>
<td></td>
<td>3 10 C</td>
<td></td>
</tr>
<tr>
<td>7647010</td>
<td>Hydrogen chloride; muriatic acid</td>
<td></td>
<td>5 7 C</td>
<td></td>
</tr>
<tr>
<td>7664393</td>
<td>Hydrogen fluoride, as F</td>
<td></td>
<td>3 2.5 6 --</td>
<td></td>
</tr>
<tr>
<td>7722841</td>
<td>Hydrogen peroxide, as H$_2$O$_2$</td>
<td></td>
<td>1 1.4</td>
<td></td>
</tr>
<tr>
<td>7783064</td>
<td>Hydrogen sulfide</td>
<td></td>
<td>10 14 50 ppm 15 21</td>
<td></td>
</tr>
<tr>
<td>26675467</td>
<td>Isoflurane</td>
<td></td>
<td>2 15</td>
<td></td>
</tr>
<tr>
<td>67630</td>
<td>Isopropyl alcohol</td>
<td></td>
<td>400 980 500 1225</td>
<td></td>
</tr>
<tr>
<td>7439976</td>
<td>Mercury, metallic and inorganic compounds as Hg</td>
<td>S</td>
<td>-- 0.025 0.1 mg/M$^3$</td>
<td></td>
</tr>
<tr>
<td>67561</td>
<td>Methyl alcohol; methanol</td>
<td>S</td>
<td>200 260 1000 ppm 250 325</td>
<td></td>
</tr>
<tr>
<td>75092</td>
<td>Methylene chloride; dichloromethane</td>
<td></td>
<td>25 87 125 435</td>
<td></td>
</tr>
<tr>
<td>7697372</td>
<td>Nitric acid</td>
<td></td>
<td>2 5 4 10</td>
<td></td>
</tr>
<tr>
<td>10102439</td>
<td>Nitric oxide</td>
<td></td>
<td>25 30</td>
<td></td>
</tr>
<tr>
<td>7727379</td>
<td>Nitrogen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75525</td>
<td>Nitromethane</td>
<td></td>
<td>2 5</td>
<td></td>
</tr>
<tr>
<td>1321126, S</td>
<td>Nitrotoluene</td>
<td></td>
<td>2 11</td>
<td></td>
</tr>
<tr>
<td>111659</td>
<td>Octane</td>
<td></td>
<td>300 1,450 375 1800</td>
<td></td>
</tr>
<tr>
<td>8012951</td>
<td>Oil (mineral) mist, particulate</td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>20816120</td>
<td>Osmium tetroxide, as Os</td>
<td></td>
<td>0.0002 0.002 0.0006 0.006</td>
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</tr>
<tr>
<td>10028156</td>
<td>Ozone</td>
<td></td>
<td>0.1 0.2 0.3 0.6</td>
<td></td>
</tr>
<tr>
<td>109660</td>
<td>Pentane</td>
<td></td>
<td>600 1,800</td>
<td></td>
</tr>
<tr>
<td>127184</td>
<td>Perchloroethylene</td>
<td></td>
<td>25 170 300 ppm 100 685</td>
<td></td>
</tr>
<tr>
<td>108952 S</td>
<td>Phenol</td>
<td>S</td>
<td>5 19</td>
<td></td>
</tr>
<tr>
<td>7664382</td>
<td>Phosphoric acid</td>
<td></td>
<td>-- 1 -- 3</td>
<td></td>
</tr>
<tr>
<td>1310583</td>
<td>Potassium hydroxide; caustic potash</td>
<td></td>
<td>-- 2 C</td>
<td></td>
</tr>
<tr>
<td>110861</td>
<td>Pyridine</td>
<td></td>
<td>5 15</td>
<td></td>
</tr>
<tr>
<td>61790532</td>
<td>Silica, amorphous, total dust</td>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>61790532</td>
<td>Silica, crystalline; quartz total dust</td>
<td></td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>1310732</td>
<td>Sodium hydroxide; caustic soda</td>
<td></td>
<td>-- 2 C</td>
<td></td>
</tr>
<tr>
<td>7664939</td>
<td>Sulfuric acid</td>
<td></td>
<td>-- 1 -- 3</td>
<td></td>
</tr>
<tr>
<td>109999</td>
<td>Tetrahydrofuran</td>
<td></td>
<td>200 590 250 735</td>
<td></td>
</tr>
<tr>
<td>108883 S</td>
<td>Toluene; toluol</td>
<td>S</td>
<td>50 188 500 ppm 150 560</td>
<td></td>
</tr>
<tr>
<td>76039</td>
<td>Trichloroacetic acid</td>
<td></td>
<td>1 5</td>
<td></td>
</tr>
<tr>
<td>1330207</td>
<td>Xylene; xylol; dimethylbenzene</td>
<td></td>
<td>100 435 300 ppm 150 655</td>
<td></td>
</tr>
</tbody>
</table>

**Footnotes to Table.** Footnotes have been edited for clarity. For the complete Cal-OSHA Table and complete footnotes, see: [http://www.dir.ca.gov/Title8/5155table_ac1.html](http://www.dir.ca.gov/Title8/5155table_ac1.html)  
(b) The substances designated by "S" in the skin notation column indicates material may be absorbed into the bloodstream through the skin, the mucous membranes and/or the eye, and contribute to the overall exposure. Appropriate protective clothing shall be provided for and used by employees as necessary;  
(d) Permissible Exposure Limit (PEL) = the maximum permitted 8-hour time-weighted average concentration of an airborne contaminant;  
(e) Parts of gas or vapor per million parts of air by volume at 25°C and 760mm Hg pressure;  
(f) Milligrams of substance per cubic meter of air at 25°C and 760mm Hg pressure;  
(g) Ceiling Limit = the maximum concentration of an airborne contaminant to which an employee may be exposed at any time. A numerical entry in this column represents a ceiling value in addition to the PEL values. A “C” notation means the value given in the PEL columns are also ceiling values;  
(h) A number of gases and vapors, when present in high concentrations, act primarily as asphyxiants without other adverse effects. A concentration limit is not included for each material because the limiting factor is the available oxygen. (Several of these materials present fire or explosion hazards.);  
(o) Short-Term Exposure Limit = a 15-minute time-weighted average airborne exposure which is not to be exceeded at any time during a workday even if the 8-hour time-weighted average is below the PEL.
What is a Safety Data Sheet? Safety Data Sheets – 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 (CCR, Title 8, 5194) 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 should:

- 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.

SDS Sources

University of California-MSDS Database
Laboratory Chemical Safety Summaries (not MSDS, but quality info aimed at labs)
Fisher Scientific MSDS
Vermont Safety Information Resources, Inc. (SIRI)
Sigma-Aldrich MSDS
MSDS Provider (Manufacturer-direct access)
Matheson’s Gases
CHEMICAL LABELING

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:

- 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
- For commercial products the name and address of the chemical manufacturer or other responsible party must be present
- Manufacturer’s product labels must remain on all containers, and must not be defaced in any way.
- Labels must be legible, in English, and prominently displayed
- Secondary containers (such as spray bottles) must be labeled with the identity of the substance and appropriate hazard warnings

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 the use of the Globally Harmonized System (GHS) of chemical classification and labeling which supersedes earlier systems. By Dec. 2013 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 chemical users should familiarize themselves with the basic aspects of this system and they will eventually see these terms used on all containers they receive from chemical 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. See the next section (Identification and Classification of Hazardous Chemicals) for definitions of the terms used here.

Most of the GHS pictograms have an equivalent in the old system, but the pictograms GHS 04, GHS 07 and GHS 08 are completely new.

<table>
<thead>
<tr>
<th>Description</th>
<th>Pictogram</th>
<th>Hazard class and hazard category:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploding Bomb</td>
<td>GHS01</td>
<td>Unstable explosives</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Explosives of Divisions 1.1, 1.2, 1.3, 1.4</td>
</tr>
<tr>
<td></td>
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Gas Cylinder
GHS04

Gases under pressure:
- Compressed gases
- Liquefied gases
- Refrigerated liquefied gases
- Dissolved gases

Corrosion
GHS05

Corrosive to metals, category 1
Skin corrosion, categories 1A, 1B, 1C
Serious eye damage, category 1

Skull and Crossbones
GHS06

Acute toxicity (oral, dermal, inhalation), categories 1, 2, 3

Exclamation Mark
GHS07

Acute toxicity (oral, dermal, inhalation), category 4
Skin irritation, category 2
Eye irritation, category 2
Skin sensitisation, category 1
Specific Target Organ Toxicity – Single exposure, category 3

Health Hazard
GHS08

Respiratory sensitization, category 1
Germ cell mutagenicity, categories 1A, 1B, 2
Carcinogenicity, categories 1A, 1B, 2
Reproductive toxicity, categories 1A, 1B, 2
Specific Target Organ Toxicity – Single exposure, categories 1, 2
Specific Target Organ Toxicity – Repeated exposure, categories 1, 2
Aspiration Hazard, category 1

Environment
GHS09

Hazardous to the aquatic environment
- Acute hazard, category 1
- Chronic hazard, categories 1, 2
Identification & Classification of Hazardous Chemicals

Chemicals can be divided into different hazard classes. The class will help determine how these materials should be stored and handled and what special equipment and procedures are needed to use them safely. See also “Safe Storage of Chemicals” section.

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

FLAMMABILITY HAZARDS
A number of highly flammable substances are in common use in campus laboratories. Flammable liquids include those chemicals that have a flashpoint of less than 100 degrees Fahrenheit. These materials must be stored in flammable storage cabinets in aggregate quantities of 10 gallons or more. Flame-resistant laboratory coats must be worn when working with large quantities (1 liter or more) of flammable materials and/or with procedures where a significant fire risk is present (e.g., when working with open flame, etc.). These materials can constitute a significant immediate threat and should be treated with particular care, even though the use of these materials is fairly common in the laboratory setting. Particular attention should be given to preventing static electricity and sparks when handling flammable liquids, i.e., when pumping flammable liquids between containers.

REACTIVE HAZARDS
Reactive substances are materials that decompose, or cause decomposition of other materials, under conditions of mechanical shock, elevated temperature, or chemical action, and release of large volumes of gases and heat. These materials must be handled with utmost care and individuals must thoroughly understand their properties. Reactive hazards fall into a number of categories:

Oxidizers - A material that readily yields oxygen or other oxidizing gas, or that readily reacts to promote or initiate combustion of organic materials. Examples: nitric, chromic, and perchloric acids; nitrates; nitrites; hydrogen peroxide. Typically oxygen-rich materials. These are probably the most common laboratory reactive hazards. Oxidizers are generally not unstable themselves, but contact with combustible material (e.g., organic solvent) can result in violent reaction/fire.

Pyrophorics – a material that will spontaneously ignite in air below a temperature of 130°C. Examples: t-butylithium, silane, diborane, trimethylaluminum
**Water Reactives** – explodes; violently reacts; produces flammable, toxic, or other hazardous gases; or evolves enough heat to cause self-ignition upon exposure to water. Examples: sodium or potassium metal, aluminum alkyls, diethylzinc

**Unstable Reactive** – will vigorously polymerize, decompose or condense, becomes self-reactive, or otherwise undergo a violent chemical change under conditions of shock, pressure or temperature. Examples: picric acid, hydrogen peroxide greater than 50 percent, hydrazine, dinitrobenzene, nitromethane, acrolein

**Organic Peroxides** - an organic compound that contains the R-O-O-R structure. Some can present an explosion hazard, or they can be shock-sensitive or temperature sensitive. Examples: will have the term “peroxide” or “peroxy” in the name.

**Peroxide-formers** - a chemical that when exposed to air, will form potentially explosive peroxides which are shock, pressure and temperature sensitive. Examples: ethers are the most common examples, but includes other types of solvents and materials. Peroxide formation is a complex subject because the rate of peroxidation and instability of the resulting peroxide vary widely depending on the starting material. For more information see: [http://www.cchem.berkeley.edu/cchasp/?q=node/19](http://www.cchem.berkeley.edu/cchasp/?q=node/19)

**HEALTH HAZARDS**

Cal/OSHA uses the following definition for health hazards:

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

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

**Corrosive Substances**

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

- Strong acids – e.g., sulfuric, nitric, hydrochloric
- Strong bases – e.g., sodium hydroxide, potassium hydroxide and ammonium hydroxide
- Dehydrating agents – e.g., sulfuric acid, sodium hydroxide, phosphorus pentoxide and calcium oxide
- Oxidizing agents – e.g., hydrogen peroxide, chlorine and bromine.
Symptoms of exposure for inhalation include a burning sensation, coughing, wheezing, laryngitis, shortness of breath, nausea, and vomiting. For eyes, symptoms include pain, blood shot eyes, tearing, and blurring of vision. For skin, symptoms may include reddening, pain, inflammation, bleeding, blistering and burns. As a physical hazard, corrosive substances may corrode materials they come in contact with and may be highly reactive with other substances.

**Irritants**

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

**Sensitizers**

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

**Hazardous Substances with Toxic Effects on Specific Organs**

- Hepatotoxins – i.e., substances that produce liver damage, such as nitrosamines and carbon tetrachloride
- Nephrotoxins – i.e., agents causing damage to the kidneys, such as certain halogenated hydrocarbons
- Neurotoxins – i.e., substances which produce their primary toxic effects on the nervous system, such as mercury, acrylamide and carbon disulfide
- Biotoxins – biologically-derived toxins, such as botulinum toxin, tetrodotoxin. Some of these are regulated under the U.S. Patriot Act as “select agents”
- Agents which act on the hematopoietic system – e.g., CO and cyanides which decrease hemoglobin function and deprive the body tissues of oxygen
- Agents which damage lung tissue – e.g., asbestos and silica.

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

**Particularly Hazardous Substances**

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

Substances that pose such significant threats to human health are classified as "particularly hazardous substances" (PHSs). The OSHA Laboratory Standards requires that special provisions be established to prevent the harmful exposure of researchers to PHSs, including the establishment of designated areas for their use. In most cases the entire lab where the material is used would be the designated area per Standard Operating Procedure for that material(s). See Section I.

**Particularly hazardous substances** are divided into three primary types:

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

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

**Reproductive Toxins**  
Reproductive toxins include any chemical that may affect the reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogenesis).


Reproductive toxins can affect the reproductive health of both men and women. For women, exposure to reproductive toxins during pregnancy can cause adverse effects on the fetus; these effects include embryolethality (death of the fertilized egg, embryo or fetus), malformations (teratogenic effects), and postnatal functional defects. For men, exposure can lead to sterility.

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

**Carcinogens** (see next section)
Carcinogen Safety Program

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

Select carcinogens are materials which have met certain criteria established by the National Toxicology Program (NTP) or the International Agency for Research on Cancer (IARC) regarding the risk of cancer. There are hundreds of materials in this category. It is important to recognize that some substances involved in research are new compounds and have not been subjected to testing for carcinogenicity. The following references (links provided) are used to determine which substances are select carcinogens by Cal/OSHA’s classification:

- OSHA Carcinogen List (see next page)
- Annual Report on Carcinogens published by the NTP, including all of the substances listed as "known to be carcinogens" and some substances listed as "reasonably anticipated to be carcinogens"
- IARC list including all of Group 1 "carcinogen to humans" materials; and some in Group 2A or 2B. See above link.

Regulated Carcinogens fall into a higher hazard class and have extensive additional OSHA requirements associated with them. The most common ones found in the lab are formaldehyde, methylene chloride and benzene. The use of these agents may require personal exposure sampling. When working with Regulated Carcinogens, it is particularly important to review and effectively apply engineering and administrative safety controls as the regulatory requirements for laboratories that may exceed threshold values for these chemicals are very extensive.

Managing Carcinogens
The safe use of all carcinogens should be addressed in the lab-specific Chemical Hygiene Plan (SOPs) of each lab using these materials – See Sec. I. EH&S does periodic reviews of labs using regulated carcinogens to determine if there is reason to believe that exposure levels exceed the Cal-OSHA limits. The review process is described in Sec. III.C.3. Typically, if these materials are used in a certified fume hood and proper PPE is utilized, there is little reason to believe exposure levels are a concern. In some circumstances, EH&S will do periodic exposure monitoring to verify this. In the unlikely event exposure limits are exceeded, additional steps must be taken under to eliminate the exposure, or protect the individual.
Regulated Carcinogens

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

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

Those materials marked in **bold** have the additional requirement of needing to be reported to Cal-OSHA as being in use at a workplace (CCR, Title 8, 5209). If you possess, or are going to order, any of these materials, please contact EH&S. These materials are rarely used in research labs.
GENERAL PROCEDURES FOR WORKING WITH HAZARDOUS CHEMICALS

(adapted from Prudent Practices in the Laboratory, National Academies Press, 2011)

Personal Behavior
Demonstrating prudent behavior within the laboratory is a critical part of a culture of safety. This includes following basic safety rules and policies, being cognizant of the hazards within the laboratory, and exhibiting professionalism with co-workers. Maintaining an awareness of the work being performed in nearby hoods and on neighboring benches and any risks posed by that work is also important.

Minimizing Exposure to Hazardous Chemicals
Take precautions to avoid exposure by the principal routes, that is, contact with skin and eyes, inhalation, and ingestion. The preferred methods for reducing chemical exposure are, in order of preference,

1. substitution of less hazardous materials or processes
2. engineering controls,
3. administrative controls, and
4. personal protective equipment (PPE)

See also the Occupational Safety and Health Administration’s (OSHA) Safety and Health Management eTool, Hazard Prevention and Control module available at www.osha.gov. Before beginning work, review all proposed laboratory procedures thoroughly to determine potential health and safety hazards. Refer to the Safety Data Sheets (SDS) for guidance on exposure limits, health hazards and routes of entry into the body, and chemical storage, handling, and disposal. Avoid underestimating risk when handling hazardous materials.

Engineering Controls
Engineering controls are measures that eliminate, isolate, or reduce exposure to chemical or physical hazards through the use of various devices. Examples include laboratory chemical hoods and other ventilation systems, shields, barricades, and interlocks. Engineering controls must always be considered as the first and primary line of defense to protect personnel and property. When possible, PPE is not to be used as a first line of protection. For instance, a personal respirator should not be used to prevent inhalation of vapors when a laboratory chemical hood (formerly called fume hoods) is available.

Avoiding Ingestion of Hazardous Chemicals
Eating, drinking, smoking, gum chewing, applying cosmetics, and taking medicine in laboratories where hazardous chemicals are used or stored should be strictly prohibited. Food, beverages, cups, and other drinking and eating utensils should not be stored in areas where hazardous chemicals are handled or stored. Glassware used for laboratory operations should never be used to prepare or consume food or beverages. Laboratory
refrigerators, ice chests, cold rooms, and ovens should not be used for food storage or preparation. Laboratory water sources and deionized laboratory water should not be used as drinking water. Never wear gloves or laboratory coats outside the laboratory or into areas where food is stored and consumed, and always wash laboratory apparel separately from personal clothing.

**Avoiding Inhalation of Hazardous Chemicals**

Conduct all procedures involving volatile toxic substances and operations involving solid or liquid toxic substances that may result in the generation of aerosols in a laboratory chemical hood. Air-purifying respirators are required for use with some chemicals if engineering controls cannot control exposure. Significant training, along with a medical evaluation and respirator fit, are necessary for the use of respirators. Contact the campus Industrial Hygienist for more information about respirator fitting and use.

Laboratory chemical hoods should not be used for disposal of hazardous volatile materials by evaporation. Such materials should be treated as chemical waste and disposed of in appropriate containers according to institutional procedures and government regulations.

**Avoiding Injection of Hazardous Chemicals**

Solutions of chemicals are often transferred in syringes, which for many uses are fitted with sharp needles. The risk of inadvertent injection is significant, and vigilance is required to avoid an injury. Use special care when handling solutions of chemicals in syringes with needles. When accompanied by a cap, syringe needles should be placed onto syringes with the cap in place and remain capped until use. Do not recap needles, especially when they have been in contact with chemicals. Remove the needle and discard it immediately after use in the appropriate sharps containers. Blunt-tip needles, including low-cost disposable types, are available from a number of commercial sources and should be used unless a sharp needle is specifically required to puncture rubber septa or for subcutaneous injection.

**Avoiding Skin Contact with Hazardous Chemicals**

All laboratory operations must be conducted in accordance with the campus Personal Protective Equipment (PPE) policy. In general, a lab coat and safety glasses are the minimum required PPE when working in the laboratory. Ordinary prescription glasses do not provide adequate protection against injury because they lack side shields and are not resistant to impact, but prescription safety glasses and chemical splash goggles are available. Please see the section on PPE in this document for further information.

**Housekeeping**

A definite correlation exists between orderliness and the level of safety in the laboratory. In addition, a disorderly laboratory can hinder or endanger emergency response personnel. The following housekeeping rules should be adhered to:
• Never obstruct access to exits and emergency equipment such as fire extinguishers and safety showers. Comply with local fire codes for emergency exits, electrical panels, and minimum aisle width.

• Store coats, bags, and other personal items in the proper area, not on the benchtops or in the aisles.

• Do not use floors, stairways, and hallways as storage areas. Items stored in these areas can become hazards in the event of an emergency.

• Keep drawers and cabinets closed when not in use, to avoid accidents.

• Properly label in permanent marker and store all chemicals appropriately by compatibility.

• Label transfer vessels with the full chemical name, manufacturer’s name, hazard class, and any other special warnings.

• Store chemical containers in order and neatly. Face labels outward for easy viewing. Containers themselves should be clean and free of dust. Containers and labels that have begun to degrade should be replaced, repackaged, or disposed of in the proper location. Do not store materials or chemicals on the floor because these may present trip and spill hazards.

• Keep chemical containers closed when not in use.

• Secure all compressed gas cylinders to walls or benches in accordance with regulation and the local requirements for seismic safety.

• Secure all water, gas, air, and electrical connections in a safe manner.

• Return all equipment and laboratory chemicals to their designated storage location at the end of the day.

• To reduce the chance of accidentally knocking containers to the floor, keep bottles, beakers, flasks, and the like at least 2 in. from the edge of benchtops.

• Keep work areas clean (including floors) and uncluttered.

• To avoid flooding, do not block the sink drains. Place rubber matting in the bottom of the sinks to prevent breakage of glassware and to avoid injuries.

• Do not pile up dirty glassware in the laboratory. Wash glassware carefully. Remember that dirty water can mask glassware fragments. Handle and store laboratory glassware with care. Discard cracked or chipped glassware promptly.
• Dispose of all waste chemicals properly and in accordance with organizational policies.

• Dispose of broken glass and in a specially labeled container for broken glass. Treat broken glassware contaminated with a hazardous substance as a hazardous substance.

• Dispose of sharps (e.g., needles and razor blades) in a specially labeled container for sharps. Treat sharps contaminated with a hazardous substance as hazardous substances.

Transport of Chemicals
When transporting chemicals outside the laboratory or between stockrooms and laboratories, use only break-resistant secondary containment. Commercially available secondary containment is made of rubber, metal, or plastic, with carrying handle(s), and is large enough to hold the contents of the chemical containers in the event of breakage. Re-sealable plastic bags serve as adequate secondary containment for small samples. When transporting cylinders of compressed gases, the cylinder must always be strapped in a cylinder cart and the valve protected with a cover cap. When cylinders must be transported between floors, passengers should not be in the elevator.

Working with Scaled-Up Reactions
Special care and planning is necessary to ensure safe scaled-up work. Scale-up of reactions from those producing a few milligrams or grams to those producing more than 100 g of a product may magnify risks by several orders. Although the procedures and controls for large-scale laboratory reactions may be the same as those for smaller-scale procedures, significant differences may exist in heat transfer, stirring effects, times for dissolution, and the effects of concentration—all of which need to be considered. When planning large-scale work, practice requires consulting with experienced workers and considering all possible risks. Although one cannot always predict whether a scaled-up reaction has increased risk, hazards should be evaluated if the following conditions exist:

• The starting material and intermediates contain functional groups that have a history of being explosive (e.g., N—N, N—O, N—halogen, O—O, and O—halogen bonds) or that could explode to give a large increase in pressure.

• A reactant or product is unstable near the reaction or workup temperature. A preliminary test to determine the temperature and mode of decomposition consists of heating a small sample in a melting-point tube.

• A reactant is capable of self-polymerization.

• A reaction is delayed; that is, an induction period is required.

• Gaseous byproducts are formed.
• A reaction is exothermic. What can be done to provide, or regain, control of the reaction if it begins to run away?

• A reaction requires a long reflux period. What will happen if solvent is lost owing to poor condenser cooling?

• A reaction requires temperatures less than 0 °C. What will happen if the reaction warms to room temperature?

• A reaction involves stirring a mixture of solid and liquid reagents. Will magnetic stirring be sufficient at large scale or will overhead mechanical stirring be required? What will happen if stirring efficiency is not maintained at large scale?

In addition, thermal phenomena that produce significant effects on a larger scale may not have been detected in smaller-scale reactions and therefore could be less obvious than toxic or environmental hazards. Thermal analytical techniques should be used to determine whether any process modifications are necessary. Consider scaling up the process in multiple small steps, evaluating the above issues at each step. Be sure to review the literature and other sources to fully understand the reactive properties of the reactants and solvents, which may not have been evident at a smaller scale.
Fume Hood Usage Guide: Standard Hoods

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

Per Cal-OSHA regulations, users of hoods must be trained on use of their fume hood. Attendance at one of the live or on-line lab safety orientations described below on the “Campus 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.

1. **Always work with the sash at 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 (10 - 100 times more than full open sash) against airborne chemicals
   - protect you better from incidents within the hood

2. *All hoods on campus are equipped with an air flow monitor and/or alarm to warn you if the air velocity is too low – see examples 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.

3. Always work at least 6 inches inside the hood to maximize capture efficiency.

4. 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.

5. 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).

*“Magnihelic gauge” – note normal gauge position. Significant deviation may indicate condition of low air flow.  
*Visible/audible alarm  Sounds during low-flow
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 one of the live or on-line lab safety orientations described below on the “Campus 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.

Variable Air Volume (VAV) hoods — unlike a standard hood above — automatically adjust the face velocity to stay within recommended safe work levels (~ 100 ft./min). A VAV hood is easily distinguished by the gray control box on the hood – pictured below.

1. **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).

2. 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 up to 100 times more than at sash full open.
   - The lower the sash, the greater the energy conservation – lower sash when not in use

3. 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 the air flow into the lower slot.
   - Most lab fires/explosions occur in hoods. Minimizing chemical volumes will reduce the chances of a small accident escalating into a large one.

4. Always work at least 6 inches inside the hood to maximize hood capture efficiency.
Safe Storage of Chemicals

INTRODUCTION: If incompatible chemicals are mixed a fire, explosion, or toxic release can occur. In earthquake-prone areas like UCSB, it is vital that chemicals be stored safely. Note however, that chemicals can often fall into more than one hazard category and therefore the chemical label and/or Safety Data Sheet (MSDS) should be reviewed for 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. This chart indicates the most obvious chemical incompatibilities, and provides a basic segregation plan.

ACIDS: Examples: Acetic Acid; Chromic Acid*; Hydrochloric Acid; Hydrofluoric Acid; Nitric Acid*; Perchloric 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 from chemicals which could generate toxic gases such as NaCN, iron sulfide, etc.

BASES: Examples: Ammonium Hydroxide; Potassium Hydroxide; Sodium Hydroxide

Storage Precautions:
- Separate bases from acids.
- Store bottles on low shelf areas, or in acid cabinets.

FLAMMABLES—fuels are reducing agents, examples:

<table>
<thead>
<tr>
<th>Acetone</th>
<th>Ethyl Ether</th>
<th>Propanol</th>
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<tbody>
<tr>
<td>Benzenne</td>
<td>Gasoline</td>
<td>Tetrahydrofuran</td>
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<tr>
<td>Cyclohexane</td>
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<td>Toluene</td>
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<td>Xylene</td>
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<tr>
<td>Ethyl Acetate</td>
<td>Methanol</td>
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</table>

Storage Precautions:
- Store in approved flammable storage cabinet(s) (required if there is > 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) refrigerator
OXIDIZERS—react violently with organics (solvents, paper, wood, etc.)

**Example Solids**
- Iodine
- Nitrates, Salts of
- Peroxides, Salts of
- Potassium Ferricyanide
- Sodium Nitrite

**Liquids**
- Bromine
- Hydrogen Peroxide
- Nitric Acid
- Perchloric Acid
- Chromic Acid

**Storage Precautions:**
- Keep away from organic solvents, and other combustible materials (i.e. paper).
- Keep away from reducing agents.

PEROXIDE-FORMING CHEMICALS—peroxides can be explosive and shock-sensitive.

Examples: Ethers and acetals with alpha-hydrogen (e.g. ethyl ether, THF); Alkenes with allylic hydrogen (e.g. cyclohexene). Store tightly sealed to exclude oxygen. Label with date of receiving/opening. Dispose within recommended guidelines—usually 6 months for ethers.

PYROPHORIC SUBSTANCES—spontaneously ignite in air.

Examples: Some finely divided metals; Some organoaluminum compounds (LiAlH₄, Al(CH₃)₃); Silane; phosphorus, yellow (should be stored and cut under water)

**Storage Precautions:**
- Rigorously exclude air and water from container.
- Store away from flammables.

WATER REACTIVES—react violently with water to yield flammable or toxic gases.

**Solids:** Calcium carbide, magnesium, lithium, potassium, sodium

**Liquids:** phosphorous trichloride, thionyl chloride

**Storage Precautions:**
- Rigorously avoid exposure to water and air
- Store away from flammables
- Lithium, Potassium and sodium should be stored under kerosene or mineral oil

HIGHLY TOXICS, CARCINOGENS, REPRODUCTIVE TOXIN 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.

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

Examples: Formaldehyde; Carbon disulfide; Mercury; Nickel carbonyl; Cyanide solutions

**Gases**—Store in a gas cabinet or other ventilated cabinet

Examples: Chlorine; Fluorine; Hydrogen chloride; Nitric Oxide; Hydrogen Cyanide

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

Examples: Cyanides, Salts of; Sulfides, Salts of
Refrigerators and Freezers in Labs

Certain refrigerator/freezer units are designed specifically for the 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. 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 refrigerator/freezer, or using an existing one, consider whether chemicals will be used for storage in this unit. Note that many lab refrigerators will be around for decades and therefore one can not guarantee that a normal unit will never be used for flammables storage. 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. Used for storage of volatile materials in areas with explosive atmospheres. These are 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 not approved for storage of flammable materials must be affixed with signage reading, “Explosion Hazard”. Please feel free to contact EH&S for your free labels.
UC Policy on Laboratory Safety Training

Documentation of occupationally-related safety training is a legal requirement under Cal-OSHA. In the first half of 2013 it is anticipated that the UC system will adopt a new policy entitled: Laboratory Safety Training that will supersede the current UCSB policy. Both policies require that all “lab workers” complete an EH&S “laboratory safety orientation” in order to be given access to their lab(s) by their department. Class descriptions and enrollment directions are given below.

Note that the trainings below are generic and do not address the specific hazards, procedures and practices for a particular laboratory, or individual. Lab supervisors/PIs are still responsible under the law for ensuring this has been provided. The training covers the core/universal issues common to most/all labs and addresses some (not all) specific regulatory requirements for documented training. Enrollment directions and class descriptions are below.

The primary new requirement in the system-wide policy is for a Training Needs Assessment to be performed for each lab worker. For new lab workers the form is automatically generated when the worker attends the fundamentals of lab safety class noted above. The worker is instructed to work with their supervisor to complete the assessment of what safety training is needed based on their assigned work. Training can and should include lab-specific instruction done by/within the lab group and EH&S provided general training. The form also serves as a convenient place to document training.

Summary of Required General Laboratory Safety Orientations

1. **Required for Graduate Students:** A live 3-hour instructor-led general laboratory safety orientation (LS01) is offered regularly - generally twice per quarter. This training is more in-depth than those listed below and generally includes hands-on fire extinguisher training. This training is open to any laboratory worker and all are encouraged to take this course.

2. **Required for Other (Non-Graduate Student) Laboratory Workers,** (e.g., postdoctoral scholars, undergraduates working in research labs, visitors, etc.). Complete the appropriate one of the two online modules below. Alternatively, a PI/supervisor may, at their discretion, choose to send a worker to the more in-depth live training in #1.

   -  **Laboratory Safety Orientation for Chemical Users (LS40)**
   -  **Laboratory Safety Orientation for Non-Chemical Users (LS41)**
LABORATORY WORKER SAFETY TRAINING: 
NEEDS ASSESSMENT and DOCUMENTATION

Under California law and UC policy, lab supervisors are responsible for ensuring that their employees have received documented safety training. Particularly, for: new employees; employees given new job assignments for which training has not previously been received; whenever new hazards are introduced, or recognized. Training can be formal or informal, and individual or group-based. This form serves two purposes relative to the above requirements:

A. Serves as a place for EH&S to document a worker’s attendance at the UC policy required Fundamentals of Laboratory Safety training (Sec. A).

B. Provides a place (Sec. B) for lab supervisors to perform two tasks that meet regulatory requirements and UC policy:
   1. Perform a “training needs assessment” for that individual, including EH&S-provided and lab-level training. An assessment is required per UC policy for laboratory workers.
   2. Document the training as it is completed.

---

**Employee Name (print) _______________________ Lab Location: ______________________
Faculty Supervisor: _________________________ Department: ________________________
Immediate Supervisor (if different than Faculty Supervisor): ____________________________

---

**SECTION A: FUNDAMENTALS OF LABORATORY SAFETY TRAINING (This section is completed by Environmental Health & Safety (EH&S))

On ____________, the above employee attended the Fundamentals of Laboratory Safety Class and received training in the following.

- Employee Rights & Responsibilities/IIPP
- Roles: Lab supervisor & Dept. Safety Rep
- OSHA Lab Safety Standard
- Safety Information Resources
- Hazard Reporting Form
- Toxicology
- Chemical Hazard Classes
- (Material) Safety Data Sheets
- Fume Hoods
- Personal Protective Equipment/Policy
- Fire Safety/Smoking Policy
- Fire Extinguisher Hands-on: live version only
- Physical Hazards
- Lockout of Energized Equipment
- Hazardous Waste Disposal
- Ergonomics Program
- Emergency Response

Class Exam: _____Passed _____ Failed _____Not Applicable

I understand the above training that I have received and agree to comply with safe work practices.

_________________________   __________________
Employee’s Signature                Date
SECTION B: LABORATORY-SPECIFIC TRAINING NEEDS ASSESSMENT & DOCUMENTATION COMPLETION OF THE FOLLOWING SECTION IS THE RESPONSIBILITY OF THE LABORATORY SUPERVISOR

Local Training Issues for Every Campus Laboratory Worker

Relevant Aspects of “Department Emergency Operations Plan” (DEOP)
Local Department Safety Rep (DSR) has written DEOP which workers have right to see upon request. However, at minimum, supervisor must ensure that all employees have received training on:

- Emergency Assembly Point
- Emergency exits
- Location of fire extinguishers and fire alarm pull stations
- Location of nearest first aid kits
- Location of emergency shower and eyewash stations

All/most of above info should already be on the last page (“Building Specific Information”) of your wall-mounted UCSB Emergency Information Flipchart. Available from your local Dept. Safety Rep.

Trainer name: _____________ Worker’s initials: _______ Date of training: ________

Research Dependent Training

I – Training Offered by EH&S and Others
The training noted here are mandatory per regulation and/or campus policy for users. EH&S or the Animal Resource Center regularly offer the mandatory baseline trainings and refreshers noted below. Where needed they should be augmented by training at the lab level. For example, training on the specifics of the lab’s Biological Use Authorization, or Radiation Use Authorization. A place to document both lab-level and centralized training is provided here.

Radioactive Isotope User: Yes ___ No___ EH&S Training1 Date______
Lab-level training date_____ Trainer initials____ Worker initials____

X-ray Equipment User: Yes___ No___ EH&S Training2 Date ______
Lab-level training date: _____ Trainer initials: _____ Worker initials:____

Biosafety Level II User: Yes ___ No____ EH&S Training1 Date ______
Lab-level training date _____ Trainer initials_____ Worker initials____

Bloodborne Pathogens User: Yes___ No____ EH&S Training1 Dates: initial____ refresher____
Lab-level training date_____ Trainer initials____ Worker initials____

Aerosol Transmittable Disease User: Yes ___ No___ EH&S Training1 Dates: initial____ refresher____
Lab-level training date:_____ Trainer initials:_____ Worker initials:____

Autoclave User: Yes___ No____ EH&S Training1 Date:______
Lab-level training date_____ Trainer initials_____ Worker initials____

Research Animal User: Yes ___ No____ Animal Resource Center Training3 Date:______
Lab-level training date:_____ Trainer initials_____ Worker initials:____

Footnotes: 1. Accessible via UC Learning Center (learningcenter.ucsb.edu), 2. See EH&S Radiation Safety website, 3. Via Office of Research website
II - Documented Safety Training by the Laboratory for Hazardous Operations

Under the law and campus policy the supervisor is responsible to see that documented training is completed within/by the lab. Potentially “hazardous operations” within campus labs are very diverse and EH&S only provides baseline training. There is no definition of what constitutes a “hazardous operation”, but common sense and what a reasonable person would expect should be employed in defining a local training program. Below are suggestions for hazards that are probably in this category. This is not a comprehensive list.

In some cases, external online training resources are available to assist you and indicated by a * These are found at: [http://ehs.ucsb.edu/training/lsvideo1.html](http://ehs.ucsb.edu/training/lsvideo1.html)

Completion is not automatically documented and must be done manually below. UCSB EH&S makes no guarantees as to the accuracy, applicability and availability of these external trainings.

### Chemical Hazards

<table>
<thead>
<tr>
<th>Chemical User:</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

Train on location and contents of the lab’s OSHA Chemical Hygiene Plan and laboratory-specific section of Plan. Most importantly, the chemical **Standard Operating Procedures** for that lab.

Lab-specific CHP/SOP Training date¹:__________ Trainer initials: ______ Worker initials:______

The following online modules are available to support chemical-user training efforts:

- Pyrophorics Reagents Safety*
- Carcinogen Handling Safety*
- Formaldehyde Safety*
- Hazardous Materials Shipping*
- Flash Chromatography*
- Fire Safety/Fire Extinguishers*

### Physical Hazards

<table>
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</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Training</th>
<th>Date</th>
<th>Trainer</th>
<th>Comments</th>
</tr>
</thead>
</table>

- High Pressure vessels* ___ ___ ____ _______ _________________
- Compressed Gases ___ ___ ____ _______ _________________
- High voltage/basic electrical hazards* ___ ___ ____ _______ _________________
- High Temperature ___ ___ ____ _______ _________________
- Cryogenics* ___ ___ ____ _______ _________________
- Centrifuge* ___ ___ ____ _______ _________________
- Sharps/Syringes ___ ___ ____ _______ _________________
- Equipment w/ hazardous moving parts ___ ___ ____ _______ _________________
- Ergonomics for Labs/Pipette Users* ___ ___ ____ _______ _________________
- Lasers¹ ___ ___ ____ _______ _________________
- Other___________ ___ ___ ____ _______ _________________
- Other _____________ ___ ___ ____ _______ _________________
- Other_____________ ___ ___ ____ _______ _________________

### Biological Hazards

<table>
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</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Training</th>
<th>Date</th>
<th>Trainer</th>
<th>Comments</th>
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</thead>
</table>

- Biosafety cabinet use ___ ___ ____ _______ _________________
- Other:_______ ___ ___ ____ _______ _________________
- Other_______ ___ ___ ____ _______ _________________
Non-UCSB Online Laboratory Safety Training

Documented safety training is a legal requirement of Cal-OSHA and ideally also helps prevent accidents. Within the UC system are a number of online safety training modules as listed below - the link below will lead to the trainings. However, as someone accessing these modules from outside that campus the training will not be documented. It is therefore recommended that the supervisor have the training documented at the time of completion.

Link to UC (Non-UCSB) Online Laboratory Safety Training:
http://ehs.ucsb.edu/training/lsvideo1.html

UC Online Training Catalog:
(campuses may have their own version/title for the same subject matter)

- Carcinogen Handling Safety
- Centrifugation Hazards
- Chemical Storage
- Compressed Gas & Cryogen Safety
- Day in the Life of the Lab (A PI's Perspective)
- Earthquake Safety
- Pressure Safety
- Cryogenics Safety
- Electrical Safety
- Ergonomics for the Laboratory
- Fire Safety in the Laboratory
- Fire Extinguishers Usage
- Formaldehyde Safety
- Fume Hoods
- Hazardous Materials Spill Response
- Hazardous Materials Shipping
- Material Safety Data Sheets
- Nanomaterials Handling
- Practicing Safe Science
- Pyrophoric Reagents Safety
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:

☐ By memos of understanding between UCSB, SB County Fire and the State Fire Marshal, EH&S is allowed to perform safety surveys on their behalfs. Without these agreements, these agencies would conduct their own inspections. However, to continue these agreements, their expectations are that regular self-inspections and corrections are done by every lab.

☐ 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 – revisit at end to reconcile w/ changes

1. Are personnel generating chemical waste trained with waste disposal procedures? Individuals who have not taken the UCSB Lab Safety course (live or on the EH&S website) must take this course before generating hazardous waste for disposal Online Hazardous Waste Course* (EH09)
   (*This course meets the waste management training requirements enforced by Santa Barbara County Fire Department)

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.

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6. Are all “sharps” (syringes, razor blades, etc.) disposed in puncture resistant, leak-resistant containers and sealed tightly to preclude loss of contents? Is there a designated glass disposal container in the lab? Lab personnel are designated to empty these into their bldg. dumpster – custodial staff will not do so.

**Chemical Safety**

1. Is your lab’s legally-required (Cal-OSHA) Lab-specific [Chemical Hygiene Plan](#) (CHP) completed and shared with all workers? Does your CHP address your use of OSHA Particularly Hazardous Substances (human carcinogens, acute toxins, reproductive toxins, and pyrophorics)?

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)

4. Are stored chemicals segregated according to hazard classification/compatibility (acids, bases, flammables, oxidizers, water reactives, 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. 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 and bond all containers/equipment involved in pumping flammable liquids to prevent buildup of static electricity as an ignition source.

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

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

9. 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.
Laboratory Equipment

1. Are the **eyewash and emergency shower** stations free of any obstructions which would prevent ready access? These units are tested 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 **air flow indicator** present and operational?
   - 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 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 EH&S 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 Lab Safety training course. The training however, does not cover lab specific hood use. Ensure lab members have documented their fume hood 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?

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 ("hydostatic 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 type C-clamps)?
   - 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.
   - Use of large cylinders of **highly toxic gases** must be reviewed/approved (EH&S, 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. 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?”

Laboratory refrigerators/freezers and other sensitive equipment, preferably should be connected to emergency back-up power.

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 out 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.

**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 has been completed?
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 pin intact and 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 the lab poster summarizing the UCSB Laboratory Personal Protective Equipment (PPE) Policy in place and are all affected individuals following its provisions? Do all individuals understand the different PPE requirements for Category 1, 2 and 3 hazardous materials?

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

9. Have all respirator users been certified through the Respiratory Protection Program as run by EH&S?

10. Is the level of housekeeping in the lab satisfactory?
    - No hazardous materials stored on floor
    - Aisles and corridors kept clear
    - Lack of clutter
    - Glassware that is scattered on benchtops 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 potentially negate any viable research.

11. Lab doors are fire-rated and therefore can not 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 left unattended.
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 all 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?

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:

- Seismic Protection Methods for Lab Instruments and 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)

1. All lab workers are required to complete the UCSB Lab Safety Orientation to satisfy numerous regulatory training requirements. Verify everyone has attended either the live class for grad students & staff (LS01), or completed the appropriate online course for undergrads and postdocs (LS04). Visit our training history link, to view personnel that have completed the course.

2. Are safety training records generated from the class maintained (Lab Safety Training Checklist) and available for review by employees, EH&S and outside agencies?

3. Are all employees aware of the following:

- How to access Material Safety Data Sheets (now known as Safety Data Sheets)?
- UCSB Laboratory Personal Protective Equipment policy/poster?
- 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 Automated External Defibrillator (AED), available in some departments?
- The location of the circuit breaker box?
- The location/purpose of your building’s Safety Corner bulletin board?
- The identity of your Department Safety Rep?
- The availability/purpose of the UCSB Hazard Reporting Form
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 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 hazardous waste containers. All portions of the label must be completed. Labels are available for free in all science storerooms —see below.

SEGREGATION: group waste into the following categories:
• halogenated organics (dichloromethane, chloroform) - non-halogenated organics (acetone, methanol, 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, lithium) - heavy metal solutions and salts (mercury, silver, zinc)
• strong oxidizers (nitric acid, chlorates, permanganates) - cyanides (potassium cyanide)
• unstable 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 by campus mail or fax(X8659).
  Also available on EH&S website for electronic submission:
  http://www.ehs.ucsb.edu/units/hw/hw.html
  • EH&S cannot accept responsibility for improperly labeled, packaged, and/or segregated chemicals, and will not pick them up.
  • Transferring waste into appropriate containers is the generators responsibility.
  • Waste containers become the property of EH&S and will not be returned

For more information see: http://www.ehs.ucsb.edu/units/hw/hw.html

UCSB Hazardous Waste Label
Disposal of Sharps

Sharps are defined as any object having acute corners, edges or protuberances capable of cutting or piercing, e.g. syringe needles, razor blades, glass, etc. These items cannot be disposed of in the normal lab trash or dumpsters. Every year custodians are injured by sharps in laboratory trash cans. Therefore, please follow these guidelines:

1. **Lab glassware NOT contaminated by hazardous materials (e.g. pyrex, borosilicate)**
   Custodial staff will not remove glass trash from lab. Place broken or unbroken glass into a labeled “Sharps Only” trash box or other sturdy container. Cardboard boxes specifically made for this purpose are available from scientific supply companies, or in most campus storerooms (pictured below). Then, dispose of contents into the designated red-lidded trash can (below) for your building. These are typically outside your building near the dumpster, but upon request individual labs can have their own trash can. Materials in these containers are recycled, therefore it is important that they are not significantly contaminated. For more information on this recycling program, contact [http://www.sustainability.ucsb.edu/labrats/](http://www.sustainability.ucsb.edu/labrats/)

2. **Needles and razor blades NOT contaminated by hazardous materials**
   These are particularly dangerous and require extra precautions beyond those of glassware:
   - Label a rigid puncture-proof container with the words “Sharps Waste” (cardboard is not acceptable). Storeroom-available container pictured below.
   - Place all sharps into sharps container as they are generated
   - When full, tape container closed or tightly lid containers prior to disposal
   - Place sealed sharps containers directly into the red-lidded trash can for your building.

   ![Puncture-proof container for disposal of razor blades and syringes. Available in lab storerooms.](image)

3. **Sharps contaminated by hazardous materials (not recyclable)**
   If sharps are uncontaminated use the procedures above. For contaminated sharps follow the additional procedures here:
• **Sharps contaminated with chemicals** - Sharps container as described above should be labeled as “Sharps contaminated with (chemical name)”. Give to EH&S for disposal with other chemical wastes.

• **Sharps contaminated with radioactive materials** - A sharps container as described above should be properly labeled as “Sharps contaminated with (isotope name)”. Give to EH&S for disposal.

• **Sharps contaminated with biohazardous (infectious) materials** - Sharps contaminated by biohazardous materials must be placed in approved red plastic sharps container (available in storerooms). The sealed containers must be autoclaved before disposal and within 7 days of becoming filled. Place autoclaved container in an opaque bag and place into dumpster, or glass container noted above.
This section of the document is now provided to laboratories in an electronic version only – see URL (Web address) provided below.

Web address (URL) for Section III:
http://www.ehs.ucsb.edu/units/labsfty/labrsc/manuals/section_III.pdf

Per Cal-OSHA requirements, this document needs to be reviewed and updated annually. Therefore, please refer to the web version for the most recent update. The hardcopy in this binder is based on the web version from March 2013 (which is the current version on the EH&S website as of August 13, 2014) and is only provided for your convenience, without implying that it is the current version.

Questions can be directed to David.Vandenberg@ehs.ucsb.edu

See also the Table of Contents – UCSB Chemical Hygiene Plan webpage at
http://www.ehs.ucsb.edu/units/labsfty/labrsc/chemistry/LschemaContentsCHP.htm
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Section III: REGULATORY FRAMEWORK

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A. THE LABORATORY SAFETY STANDARD

1. Background

The Standard for *Occupational Exposure to Hazardous Chemicals in Laboratories* (commonly known as the “Laboratory Safety Standard”, or “Chemical Hygiene Plan”) was adopted by the California Occupational Health & Safety Administration (Cal/OSHA) Standards Board on February 21, 1991. The Laboratory Standard is summarized on the following page and the [complete text](http://www.dir.ca.gov/Title8/5191.html) of the Laboratory Standard 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, and other health and safety professionals, 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 relatively small scale procedures. In many labs, particularly those involved in research, the character of chemical usage can also change significantly over time to reflect evolving research conditions.

The Laboratory Standard is a performance standard. That is, there are few specific requirements to carry out procedures in a certain way. This allows the University administration and lab supervisors to make their own decisions, within the spirit (and limitations) of the Laboratory Standard, to determine the means for worker protection. These policy and procedure decisions are formalized within this written Chemical Hygiene Plan and within the lab-specific variations on campus.

2. Applicability

The Laboratory Standard does not apply to all places where hazardous chemicals are used in experiments and investigations. Labs meeting the following four criteria are subject to the Laboratory Standard:

- Chemical manipulations are carried out on a laboratory scale. That is, chemical containers are of a size that could be easily and safely manipulated by one person.
- Multiple chemical procedures are used.
- The procedures involved are not part of a production process, nor in any way simulate a production process.
- Protective laboratory practices and equipment are available and commonly used.

Clearly, most research and teaching laboratories here at UCSB, meet these criteria and therefore fall under the scope of the Laboratory Standard.

Students in campus teaching laboratories are not employees of the University and therefore do not fall under the provisions of the Laboratory Standard. Although not legally required to be given the same consideration as employees, it is the judgment of the University, that it is obligated to develop policies, procedures and course lab manuals which attempt to provide the same level of protection for students. It should also be noted that teaching assistants (TAs), faculty and staff who teach 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. Each of these is addressed within the sections of this manual as noted:

- **Chemical Hygiene Plan (CHP)** — A written plan 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. [this document]

- **Responsibilities** — Personnel responsible for implementation of the CHP must be designated, including the appointment of a Chemical Hygiene Officer. [Sec. III.B.2]

- **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]

- **Exposure Limits** — Occupational exposures to chemicals must not exceed specified Cal-OSHA levels. [Sec. III.C.3]

- **Employee Exposure Determination** — As appropriate, measurements must be taken to verify that exposure limits are not exceeded. [Sec. III.C.3]

- **Medical Consultation and Examinations** — Employees are entitled to medical attention when a significant chemical exposure is suspected. [Sec. III.C.4]

- **Hazard Identification** — Safety Data Sheets (formerly known as MSDS) and other reference materials need to be available. Labeling of chemicals is strictly regulated. [Sec. III.C.2]

- **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, etc. [Sec. III.C.5]

- **Standard Operating Procedures** — SOPs must be developed, as needed, relevant to safety and health considerations when lab work involves the use of hazardous chemicals. [Secs. I and III.B.3]

- **Prior Approval** — Circumstances must be stipulated under which a particular laboratory operation, procedure or activity requires prior approval from the lab supervisor. [Sec. III.C.7]

- **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. [Secs. I and III.C.6]

- **Maintenance of Engineering Controls and Emergency Equipment** — Fume hoods comply with section 5154.1 (Title 8, CCR) and that protective equipment function properly. [Sec. III.C.8]
B. THE LABORATORY SAFETY STANDARD AT UCSB

1. Introduction

The UCSB Policy on Environmental Health and Safety (Policy P-5400) states:

The University shall maintain as safe and healthy an environment as is reasonably feasible for its students, faculty, staff and visitors by:

• Conducting its operations and activities in a safe manner to minimize the risks of injury to people and minimize property damage at all locations where University operations and/or activities occur.

• Complying with applicable regulations, safety and health consensus standards, and practices generally accepted by experts in the field.

Therefore the intent of the University is to abide by the provisions of the Laboratory Standard to as great an extent as is reasonably feasible.

2. 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. Under Cal/OSHA’s Injury and Illness Prevention Program, supervisors are responsible for protecting the health and safety of employees and students under their supervision. A helpful guideline to many common specific tasks of a lab supervisor can be found online. Supervisors can delegate specific tasks, but can not delegate their overall responsibility. General responsibilities include the following:

• Ensure that all employees under their supervision (staff and students), are aware of potentially hazardous operations (materials, processes, equipment) that could be encountered in their lab.

• Ensure training requirements are fulfilled and records are maintained, including the completion of a Training Needs Assessment for each worker—see Sec III.C.1

• Enforce safety rules within the lab, such as the wearing of personal protective equipment (Sec. III.5.D)

• Ensure personnel have the correct personal protective equipment they need to do the job safely

• Monitor the proper procurement, use and disposal of chemicals used in laboratory operations.

• Seek ways to improve chemical hygiene and laboratory safety within their operation.

• Implement policies and procedures described in this CHP, including:
  ○ the development of written Standard Operating Procedures (Sec.I) for hazardous lab operations, which involves:
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➢ determination/implementation of appropriate control measures (Sec. III.C.5),
➢ development/implementation of provisions for additional employee protection from Particularly Hazardous Substances (Sec. III.C.6), and
➢ establishing criteria for any needed prior approval processes (Sec. III.C.7).

c. Environmental Health & Safety (EH&S)

Develop safety education and monitoring programs to maintain a safe and healthy environment for faculty, staff, students and visitors in order to facilitate the research and teaching functions of the University. Support research and instructional activities by developing legally mandated programs, providing technical guidance and consulting with and assisting departments in program implementation and maintenance. Make every effort to keep operations functioning smoothly in labs while meeting health, safety and environmental obligations.

d. Chemical Hygiene Officer

The Lab Standard specifically calls for the appointment of a Chemical Hygiene Officer by the employer: “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 role at UCSB is currently 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:  David Vandenberge, EH&S Laboratory Safety Program Manager, Bldg. 565, (805) 893-4899, David.Vandenberge@ehs.ucsb.edu

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 EH&S lab safety trainings and orientations. Monitor and evaluate the effectiveness of the CHP. In cooperation with, and 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 the primary interface with Cal-OSHA regarding CHP issues.

e. Laboratory Safety Committee

The UCSB Chemical Safety Committee reviewed and approved earlier versions of the UCSB Chemical Hygiene Plan as drafted by EH&S. In 2010 the committee was superseded by the Laboratory Safety Committee (LSC) as 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 and the CHOs to receive input and direction from the campus laboratory community on the content and effectiveness of the CHP and other lab safety issues.

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 - including laboratory safety - 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.
The department may also have an Management Services Officer, safety committee, or lab manager.

- Responsible for maintaining a safe environment—including general oversight of department operations and communicating with supervisors/personnel any relevant safety issues, problem solving, and preplanning for emergencies.

- Per campus policy, departments are responsible for ensuring that all new lab workers attend one of the EH&S General Laboratory Safety orientations before access to departmental labs is granted - see also 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 for CHP development, department administrations need to coordinate and support these efforts.

g. Laboratory Workers (non-supervisors: graduate students, undergraduates, postdoctoral staff; permanent staff, visiting researchers, etc.)
   General responsibilities are below - a more complete list is online.
   - Follow the established work policies, procedures and safety guidelines, including the UC Personal Protective Equipment policy and the campus and lab-specific portions of the Chemical Hygiene Plan.
   - Attend and actively participate in appropriate safety training.
   - Notify the laboratory supervisor or EH&S of any unsafe or potentially unsafe condition.

Workers also 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 them
   - 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. Workers are encouraged to report any safety concerns to EH&S – anonymously if they wish.

h. Facilities Management
   (see also Section III: C(8))
   - Ensure the timely repair of malfunctioning physical plant equipment such as fume hoods, eye washes, safety showers, alarms, etc.
   - Notify lab personnel and/or EH&S as appropriate when equipment is inoperable or malfunctioning and may affect the safe operation of University laboratories.

3. Standard Operating Procedures

As touched on in the previous section, the incorporation of Standard Operating Procedures (SOP) into our Chemical Hygiene Plan is a requirement. Given the diverse nature of laboratory work at UCSB, it is incumbent on individual lab supervisors to develop lab-specific SOPs for operations which involve the use of a “hazardous chemical.”. Under the OSHA Standard, a “hazardous chemical” is one for which:

“...there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees.”

Standard Operating Procedures (SOPs) are written instructions that detail the steps that
will be taken during a given experimental procedure relative to safety. Development and implementation of SOPs is a core component of promoting a strong safety culture in the lab. More background:

- SOPs should contain information about potential hazards and how these hazards will be mitigated.
- PIs/Laboratory Supervisors are required to ensure laboratory-specific SOPs have been developed and implemented for “hazardous chemicals” as defined above, with special focus on “Particularly Hazardous Substances” (PHS) – human carcinogens and reproductive toxins, acutely toxic materials. (further defined in Sec. III.C.6.). In some cases chemicals with similar hazards and safety controls can be grouped together into a single SOP.
- SOPs should be written by laboratory personnel who are most knowledgeable and involved with the experimental process.
- For some SOPs, consideration should be given to whether additional consultation with safety professionals is warranted.
- Circumstances requiring prior approval from the PI/Laboratory Supervisor must also be addressed in laboratory-specific SOPs.
- SOPs should be kept in the Laboratory Safety Manual under the appropriate tab. At the time of this writing, the development of an online SOP development and storage tool is underway within UC and will be shared when ready.

Specific guidance on how to prepare SOPs are given in Section I. In some UCSB departments “communal SOPs” have been developed for sharing amongst researchers who do similar operations. Also, at the time of this writing, “UC communal SOPs” are being developed for sharing - beginning with UC departments of Chemistry & Biochemistry. However, to adequately meet regulatory requirements, it is necessary that individual PIs/lab supervisors review and customize any communal SOP to meet their specific need.

In addition to the many chemical hazards in laboratories there are, of course, many associated physical and biological hazards such as electricity, radiation, high and low temperature operations, infectious organisms, etc. The Laboratory Standard does not stipulate that these be addressed within a Chemical Hygiene Plan. However, where deemed appropriate, it is strongly recommended that these issues are also addressed by an SOP. As noted above for chemical hazards, communal SOPs for some other types of hazards are available, or being developed.
C. CHEMICAL-USE POLICIES

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 the general and specific occupational hazards identified in the workplace. In general, training is required for:

- All new employees
- 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

Regarding training specific to the Laboratory Safety Standard, an individual’s supervisor has responsibility for ensuring that personnel have had training on the elements listed below as stipulated in the Standard and any other required safety training.

UC Laboratory Safety Training Policy

In the first half of 2013 it is anticipated that the UC system will adopt a new policy entitled: Laboratory Safety Training that will supersede the current UCSB policy. Both policies require that all “lab workers” complete an EH&S “fundamentals of laboratory safety” training in order to be given access to their lab(s) by their department. Enrollment directions and class descriptions are in Sec. II: “Campus Policy on Laboratory Safety Training”. EH&S regularly offers this fundamentals training via a 3-hour live training, or Web-based version for certain audiences. Graduate students are required to take the live training.

The primary new requirement in the system-wide policy is for a Training Needs Assessment to be performed for each lab worker. A UC-developed Web tool will eventually be developed for supervisors to use in completing this task. But, for the foreseeable future an assessment and documentation form is provided in the portion of Sec. II noted above. For new lab workers the form is automatically generated when the worker attends the fundamentals of lab safety class noted above. The worker is instructed to work with their supervisor to complete the assessment of what safety training is needed based on their assigned work. Training can and should include lab-specific instruction done by/within the lab group and EH&S provided general training. The form also serves as a convenient place to document training.
### Safety Training Required by the Laboratory Safety Standard

- Employee rights and responsibilities under the Cal/OSHA Laboratory Standard and the Injury & Illness Prevention Program regulations.  
  [Covered in EH&S Lab Safety Class]

- The contents of the generic portions of the UCSB Chemical Hygiene Plan and its relation to the Laboratory Standard.  
  [Covered in EH&S Lab Safety Class]

- The contents of the lab-specific Chemical Hygiene Plan, including any Standard Operating Procedures (SOPs) that have been developed.  
  [Lab supervisor training responsibility]

- The physical and health hazards of hazardous materials including signs and symptoms of overexposure, particularly those defined as Particularly Hazardous Substances (see Sec. I and Sec. III: C(6)). As appropriate, training can address entire classes of hazardous materials (e.g., carcinogens) rather than individual substances.  
  [Major classes of chemical hazards are covered in EH&S Lab Safety Class]

- Appropriate use and maintenance of control measures including engineering controls, personal protective equipment, and work practices.  
  [Generic control measures covered in EH&S Lab Safety Class. Lab-specific control measures should be addressed in the lab’s SOPs as needed.]

- The Permissible Exposure Limits for OSHA-regulated substances.  
  [PEL concept and access to PELs covered in EH&S Lab Safety Class. Common lab chemical PELs provided in Sec. II]

- Hazardous materials labeling, storage, and signage requirements.  
  [Covered in EH&S Lab Safety Class]

- Relevance and access to SDSs (MSDS) and other informational references and resources pertinent to the lab.  
  [Use of, and general access to, SDSs covered in EH&S Lab Safety Class. Access to lab-specific SDSs is the responsibility of the lab supervisor]

- Spill response and emergency procedures.  
  [Covered in EH&S Lab Safety Class]

### EH&S Training Records

Currently, there is a Web interface which allows EH&S training records to be searched by worker name, supervisor name, or department for the period from July 2000 to approximately July 2012. EH&S-performed or online provided training which is completed after July 2012 is documented in the UC Learning Center. Individuals can access the Learning Center using their UCSB NetID and password to view EH&S trainings and their training history. Likewise, upon request, departments can have designated administrator(s) provided access to all the training records for individuals associated with their department.

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### 2. Hazard Identification

University policies on hazard identification with respect to labeling and Material Safety Data Sheets are as follows:

- Labels on incoming containers of hazardous chemicals are not to be removed or defaced.

- The primary campus access to Safety Data Sheets (formerly known as MSDS) is through the internet, particularly the UC SDS search engine. See EH&S website. 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.

3. Criteria for Establishing Exposure Monitoring

The legally-acceptable levels for occupational exposure to approximately 500 chemicals which are toxic by inhalation, or skin contact, are codified by OSHA in so-called Permissible Exposure Limit (PEL) values. These values are generally expressed in parts per million (or mg/m³) and can relate to short-term (15 min.), long-term (8 hour), or ceiling level exposures. In Sec. II is a list of PELs for some common laboratory chemicals (Exposure Limits for Laboratory Chemicals).

The University policies on dealing with employee exposure determination and exposure monitoring shall be those expressed in the Laboratory Standard (5191(d)). Initial exposure monitoring for any substance regulated by an OSHA standard will be performed if there is reason to believe that exposure levels exceed the action level, or Permissible Exposure Limit. The tasks of determining if exposure monitoring is required, performing or supervising exposure monitoring and other related duties shall be the sole responsibility of the EH&S Industrial Hygiene and Laboratory Safety Divisions. All suspected chemical exposures on campus shall be reported in a timely manner to EH&S.

For regulated carcinogens (See Sec. II) EH&S does periodic reviews of usage practices to establish if there is reason to suspect there are significant exposures. The review process typically includes: a) evaluation of the chemical inventory questionnaire for each lab; b) distribution and evaluation of a carcinogen use questionnaire if a regulated carcinogen appears on the inventory; c) exposure monitoring if usage practices suggest possible routine exposure, e.g., a material is used in larger quantities, or frequently, or outside of a fume hood.

4. 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 policies and procedures, when it is known or suspected that an employee (or student) 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. Non-employees such as students would be covered by their required medical insurance.

• If the injured/exposed person is safe and able to be transported, escort them to either Student Health Services on campus, Goleta Valley Community Hospital, or their primary physician for evaluation and examination. Contact EH&S at x3194 immediately.
• 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 circumstances 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 Laboratory Standard be followed as stipulated in that section.

5. 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. The University policies on determination and implementation of control measures are delineated here.

A. General

• Appropriate control measures shall be implemented in University laboratories to reduce chemical exposures and physical hazards to as low a degree as reasonably achievable.

• Lab supervisors shall determine and implement appropriate control measures, but in accordance with regulations and campus policy

• Environmental Health & Safety shall be responsible for assisting the above in determining and implementing these control measures. 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

• FUME HOODS, WET BENCHES, GAS CABINETS AND OTHER LOCAL EXHAUST VENTILATION
  ▪ When using volatile substances that present a significant inhalation hazard
  ▪ When necessary to keep exposure levels below OSHA Permissible Exposure Limits, or action levels
  ▪ When using toxic gases above exempt amounts as defined by CA Fire Code
  ▪ When indicated in Standard Operating Procedures
  ▪ As indicated in MSDSs

• BIOSAFETY CABINETS
  ▪ With laboratory operations involving biohazardous material as directed by National Institutes of Health (NIH) and Centers for Disease Control (CDC) guidelines and the OSHA Bloodborne Pathogens Standard
  ▪ When stipulated by the Biosafety Authorization issued by the campus Biosafety Committee
  ▪ When indicated in Standard Operating Procedures
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• GLOVE BOXES
  o When indicated in Standard Operating Procedures

• APPROVED HAZARDOUS MATERIALS STORAGE CABINETS AND SAFETY CANS
  o When CA fire code mandated volume limits for flammable liquids are exceeded
  o When indicated in Standard Operating Procedures

• FLAMMABLE STORAGE REFRIGERATORS (APPROVED-TYPE)
  o When refrigerated storage of flammable materials is needed

C. Administrative Controls—Criteria for Implementation

The variety of possible administrative controls to reduce hazard levels in laboratories is large. 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 necessary to reduce hazards as mandated by current health and safety regulations or as called for by accepted good practice

D. Personal Protective Equipment—Criteria for Implementation

The appropriate personal protective equipment (PPE) is stipulated in the UCSB policy: Laboratory Personal Protective Equipment (June 2011). The key provisions of the policy are summarized in Sec. II of this manual (Campus Policy on Laboratory Personal Protective Equipment (PPE)), including an educational poster that is mounted in all campus laboratories.

6. 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.

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, hydrogen sulfide, and nitrogen dioxide 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 laboratory supervisors to institute Standard Operating Procedure(s) for using a
specific Particularly Hazardous Substance in their laboratories. See Section I for template forms and instructions.

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/prompts for addressing these issues is provided in the SOP development section (Sec. I).

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 large diversity of chemical work performed in campus laboratories, it is impossible to specify the particular laboratory operations which would require prior approval. **It is therefore the responsibility of individual lab supervisors to establish these criteria for their operations. Establishment of prior approval criteria, if any, is solely the prerogative of the lab supervisor.** These criteria should be incorporated into the Standard Operating Procedures portion of their Lab-specific Chemical Hygiene Plan. In Section I of this document are provided template forms that lab supervisors can use for this purpose.

8. **Maintenance of Engineering Controls and Emergency Equipment**

As stated in the Laboratory Standard, provisions for maintenance of both control measures and emergency equipment must be included in the CHP: “....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....”

It is the policy of the University that all control measures designed to reduce chemical or physical hazards to employees shall be maintained in proper working order. If not functioning properly, or inadequate for the task, it is the responsibility of the campus entity responsible for the equipment to immediately inform affected workers of its status. Such equipment shall be repaired/replaced on a timely basis.

**General Responsibilities:**

**FACILITIES MANAGEMENT (FM):** Responsible for routine maintenance, replacement and installation of University-owned building emergency systems and environmental controls.

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

**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 functioning properly or if new procedures require changes or additions to existing systems.

**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. Biosafety Committee typically requires cabinet use as part of their authorization

OTHER LOCAL EXHAUST VENTILATION
  Maintenance: Facilities Management

EMERGENCY SHOWERS AND EYEWASHES (per CCR, Title 8, 5162)
  Maintenance & testing: Facilities shall check on a regular basis by running water through them until the water runs clear and repair as needed and keep records.

RESPIRATORS (per CCR, Title 8, 5144)
  Administration: EH&S has sole responsibility for approval, fit-testing and issuance. Lab supervisors are responsible for identifying and directing individuals to EH&S who may require respirators in their work.
  Maintenance: Lab supervisor or designee

OTHER PERSONAL PROTECTIVE EQUIPMENT (per CCR, Title 8, 3380-3387)
  Maintenance: Generally provided by the lab supervisor — maintenance/replacement are the responsibility of the supervisor and lab personnel

FIRE EXTINGUISHERS, DETECTORS, ALARMS, SUPPRESSION SYSTEMS (per CA Fire Code and Building Code)
  Administration: The campus Fire Marshal’s office is responsible for evaluation and approval of these systems
  Maintenance: Facilities Management

GAS DETECTION/ALARM SYSTEMS (per CA Fire Code and Building Code)
  Administration: EH&S has responsibility for evaluation and approval of code-required gas detection/alarm systems
  Maintenance: Facilities Management/Cleanroom staff

EMERGENCY PHONES
  Maintenance: Communications Services

HAZARDOUS MATERIALS SPILL RESPONSE EQUIPMENT (per CCR, Title 8, 5192)
  Maintenance: EH&S is responsible for equipping, maintaining and using the primary hazardous materials response equipment stores for the campus. Individual labs or departments may have local supplies which they maintain.