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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Table of Contents

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.

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.

UCSB Laboratory Worker Responsibilities

for Safety and Environmental Compliance

(from http://www.ehs.ucsb.edu/labsafety/overview-laboratory-worker-responsibilities-safety-and-environmental-compliance)

Every individual who works in a UCSB laboratory (employee, student, postdoctoral scholar, faculty member, or other person) has responsibilities for safety and environmental compliance.

1. Comply with applicable environmental, health and safety laws and regulations, University policy and accepted safe work practices as described in this Chemical Hygiene Plan.

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 (MSDS) for the material.

6. Always use personal protective equipment per UC policy 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.

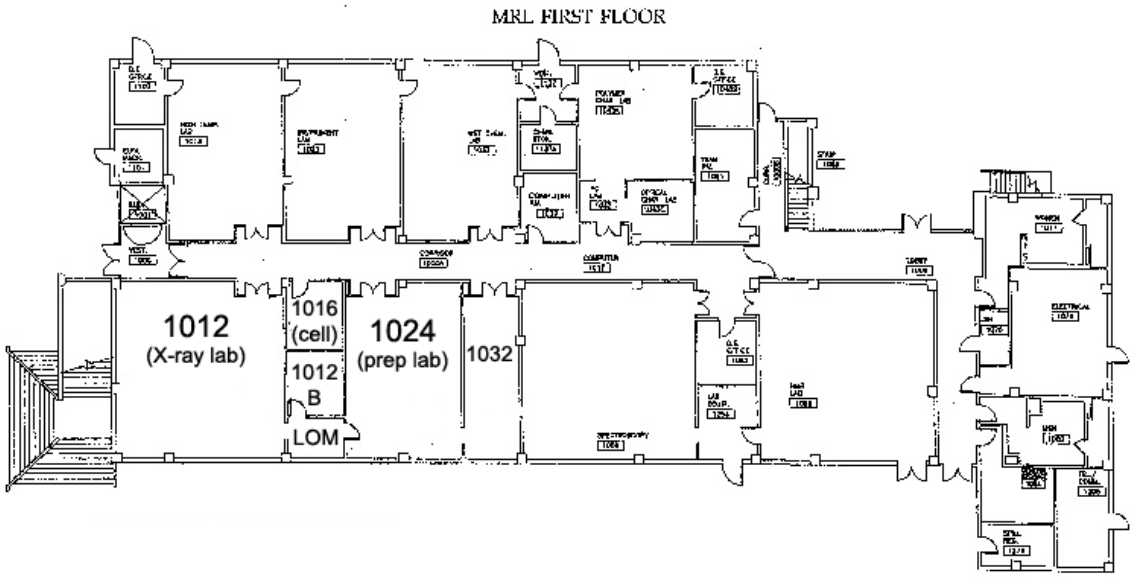
General Laboratory Information

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.

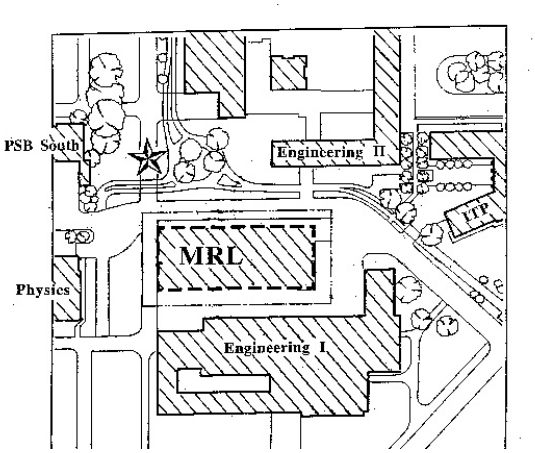
Location of the Department Safety Bulletin Board

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[1]). 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 (x7925).

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

[1] simply dialing 911 from a cell phone will not contact UCSB dispatch, but rather the Ventura dispatch, which may result in delays

available 24 hours a day. After hours, emergency personnel can be paged through this number. An SOP (Standard Operating Procedure) for handling chemical spills is provided in this CHP (page 108), 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 CO_2 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. You can find the location of Student Health Services by going to:

http://mapdev.geog.ucsb.edu/#

and searching for "Student Health".

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

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

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://www.emergency.ucsb.edu/contacts

Collection of video trainings on a variety of lab safety topics

http://www.ehs.ucsb.edu/labsafety/external-online-training

Lab Safety Fact Sheets (one page summaries of important safety issues by UCSB EH&S and links to similar resources on other campuses)

http://www.ehs.ucsb.edu/labsafety/fact-sheets

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:

- Azides, Handling Organic*
- Cadmium
- Pyrophoric Organolithium Reagents
- Water Reactive and Pyrophoric Materials

Chemical Safety:

- Chemical Storage*
- Housekeeping Guide for labs*
- Power Failures Guide*
- Quenching Solvent Drying-Still Bottoms
- Guidelines for Receiving Hazardous Materials Shipments in Non-Lab Areas
- Seismic Hazard Reduction*
- TA Guide
- Time-Sensitive Chemicals*

Lab Equipment:

- Liquid Waste Collection in a Biosafety Cabinet*
- 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://www.ehs.ucsb.edu/training/ucsb-hazardous-waste-generator-training

Sign up for this training (course code EH23) at the UC Learning Center:

https://www.learningcenter.ucsb.edu/

Accident Descriptions on the EH&S website (every accident has a lesson to teach)

http://www.ehs.ucsb.edu/labsafety/laboratory-accidents

An on-line source for Laboratory Chemical Safety Summaries (LCSSs) of some common chemicals is the book "Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards, Updated Version" (National Academies Press, 2011) available on the web as an "open book" at

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

Collection of LCSSs on PubMed:

https://pubchem.ncbi.nlm.nih.gov/lcss/

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

911	**from payphones, residence hall phones**
9 911	**from campus phones**
805 893 3446	**from cell phones (when on campus)** (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 an older "EH&S Guide to services phone list"; up to date information is available at

http://www.ehs.ucsb.edu/programs-services

UCSB Environmental Health & Safety Guide to Services

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.

Asbestos/Lead (D&CS) x7984

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 x8894

Facilitates compliance of biohazardous 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 x4559

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

Emergency Management x3154

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

Environmental Compliance x8533

The Environmental Health Program assists the campus community with its environmental (air, water & soil) health/compliance obligations. Assistance is provided in the form of information, guidance and/or technical support.

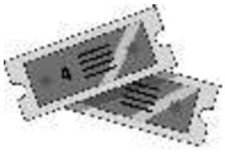
Environmental Health x8533

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

Ergonomics x3283

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 x7751



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 x4407

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 2661x2306

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.

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

dfs/ALL_EHS/Publications/Guide to Services/EHS GTS Flyer

Environmental Health & Safety Guide to Services

Hazardous Chemical Management x8243

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

Hazardous Waste Disposal x3293

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 x8787

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 x4899

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

Lab Safety x4899

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 x3588

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

Radiation Safety x3588

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 x2860

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 x7014

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 x8997

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 x8050

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

Pest Control on Campus, for example:	
Rodents, Raccoons, Insects, Birds (live):	
Facilities Management	893-2661
Dogs (running loose):	
County Animal Control	681-5285
Marine Animals:	
Live: Marine Mammal Center	687-3255
Dead: Fish & Game	568-1226
Injured Animals:	
Wildlife Care Network	966-9005
Dead Animals in buildings or on roads:	
County Animal Control	681-5285
Environmental Health Issues at Home	
County Public Health Department	681-4900
Food Permits for Student Groups	
Office of Student Life	893-8912
Hot Work Permits	
Physical Facilities - Indoors	451-8996
EH&S - Outdoors	893-3785
Household Hazardous Waste Collection Center	
County of Santa Barbara	882-3602
Recycling Program	
Associated Students	893-7765

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)

	Office Phone	Cell Phone	Email
Kai Ewert		252 4318	ewert@mrl
Bretton Fletcher		(858) 539 3409	brettonfletcher@gmail
Youli Li	x8104	252 6315	youli@mrl
Phillip Kohl		(818) 434 1322	phillipkohl@gmail
Cyrus Safinya	x8635	708 2591	safinya@mrl
Victoria Steffes		(248) 891 8066	vsteffes@chem
Amanda Strom	x7925		amanda@mrl
Christine Tchounwou		(601) 278 7397	ctchounwou@umail
Emily Wonder		(515) 975 6383	emilywonder@umail
Miguel Zepeda-Rosales	x7943	(831) 840 6820	miguelz@mrl

Safinya Lab Chores

A few times a year, we assign lab chores to the active group members. These include being responsible for certain pieces of equipment (e.g., inverted microscope), certain areas of the lab (e.g., the "LOM"), or certain tasks (e.g., ordering supplies). If you are tasked with caring for a piece of equipment chores, make sure to read the manual for this piece of equipment and learn any maintenance procedures from the person you might be taking over from (e.g. alignment and cleaning for microscopes). Getting trained by the person you are taking over from does not substitute for reading the manual though.

The current chores list, which you should consult if there is an issue with a piece of equipment, is posted in the lab.

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.

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 (course code LS60) at the UC Learning Center:

https://www.learningcenter.ucsb.edu/

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.

Fundamental 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/labsafety/lab-inspection-programs

direct link: http://www.ehs.ucsb.edu/files/docs/ls/Lab_Self_InspectionChecklist_web_August_2016.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.) While food is permitted in LOM, it must be in **a closed**

container when transitioning through the lab space. Use common sense when transporting food to the LOM, e. g., don't use the door/lab where someone is working with hazardous material.

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 (and on the UCSB campus), including the LOM area.

Do not block lab aisles with chairs, stools, or equipment. Maintain a minimum clearance of 2 ft in the aisels at all times.

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 single hood (the "liposome prep" hood) in 1024. 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. Kai also has some manuals in his office.

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.

Centrifuge Safety

The energy stored in the moving rotor of a centrifuge can be substantial and pose a hazard to equipment and personnel; the larger and faster the centrifuge, the greater the energy. It is imperative that the rotor is balanced, which is generally achieved by placing samples of identical weight in directly opposing positions. This is essential for the safety of the samples, the equipment, and the operator. A short video on centrifuge safety can be found at

https://www.youtube.com/watch?v=q_0phA034n0

(From EH&S's collection of video trainings on a variety of lab safety topics at
http://www.ehs.ucsb.edu/labsafety/external-online-training)
For additional information, see the EH&S lab safety fact sheet on centrifuges in Appendix A.

Pipetting Safety/Ergonomics

Always use a pipetting aid (e.g. rubber balloon style) and not your mouth for pipetting. If you use Eppendorf-style pipets a lot, make sure to familiarize yourself with proper pipetting technique to prevent repetitive use injuries. See, e.g. the short video at

https://www.youtube.com/watch?v=bqAsXMSs27s

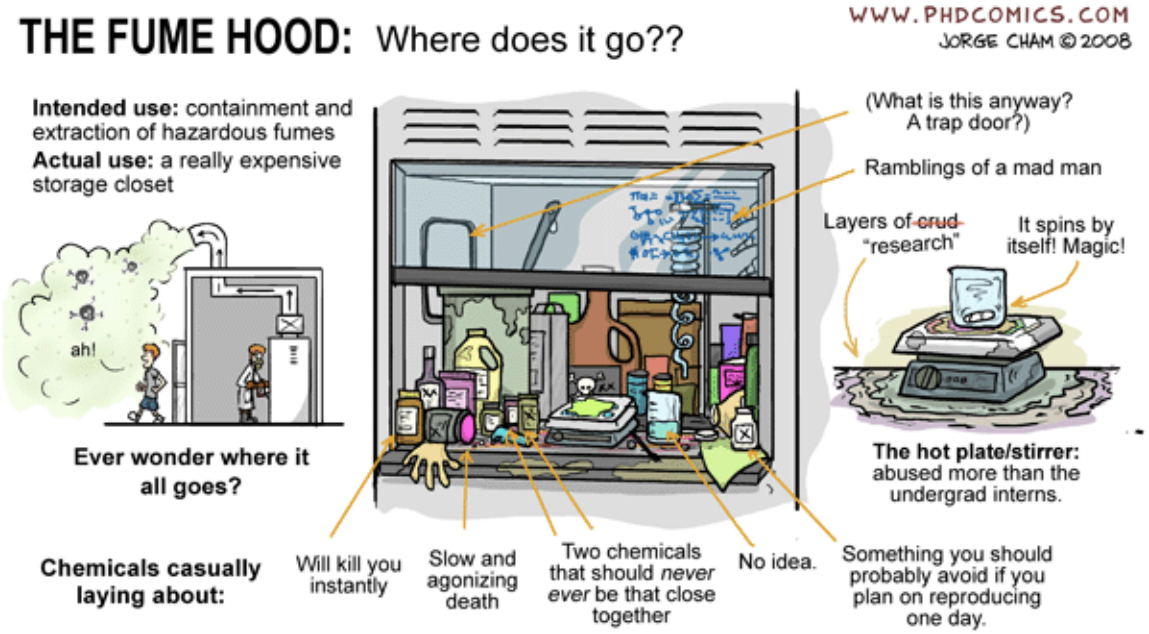
(From EH&S's collection of video trainings on a variety of lab safety topics at
http://www.ehs.ucsb.edu/labsafety/external-online-training)

It is also important to learn proper pipetting technique to make sure you don't compromise validity of your research. One point particular to our lab is using Eppendorf-style pipets for dispensing organic solvents. Due to the high vapor pressure of these solvents (e.g., chloroform, methanol), it is essential that you pipet the solvent up and down a few times before measuring it out. This prevents the vapor pressure of the solvent from pushing out some of the liquid before you transfer it. It is also important to minimize the time the pipet tips are exposed to organic solvents because the solvent will leach compounds from the plastic. A quick test to check your pipetting skills and the calibration of the pipets is to dispense water or solvent to a container on a scale, recording the weight after each addition and using the known density of the dispensed liquid to calculate how well you did.

Chemical Safety

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

A Humorous View of Chemical Safety OR What to Look Out For



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.

A single fume hood can use the same amount of energy as three to four homes (http://fumehoodcalculator.lbl.gov/). For the hoods in the Safinya labs, air flow and thus energy consumption depends on the position of the sash. Therefore, as well as for safety reasons (having many sashes open in the building will result in lower airflow because of the limited capacity of the fans serving the fume hoods) **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 this EH&S web page:

http://www.ehs.ucsb.edu/labsafety-chp/sec2/fume-hood-usage-guide-variable-air-volume-hoods-phoenix-system

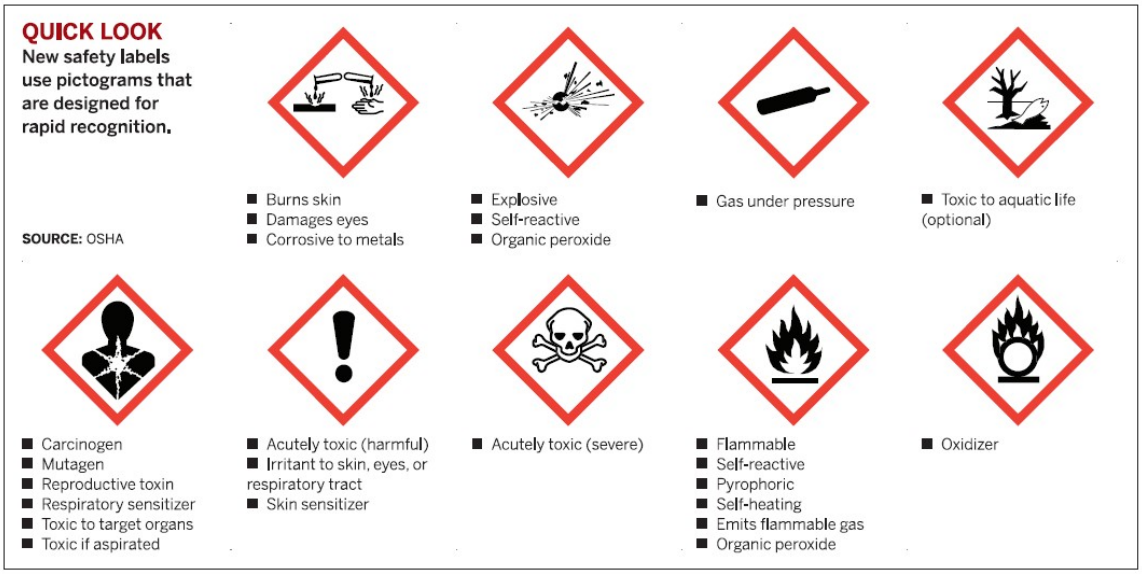
Identifying Chemical Hazards

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 listed in 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 (the current list of responsibilities/chores is posted in the lab).

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. Only use the lab coats that you have been issued; "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 heavily contaminated, it should be packaged safely and disposed of as hazardous waste.

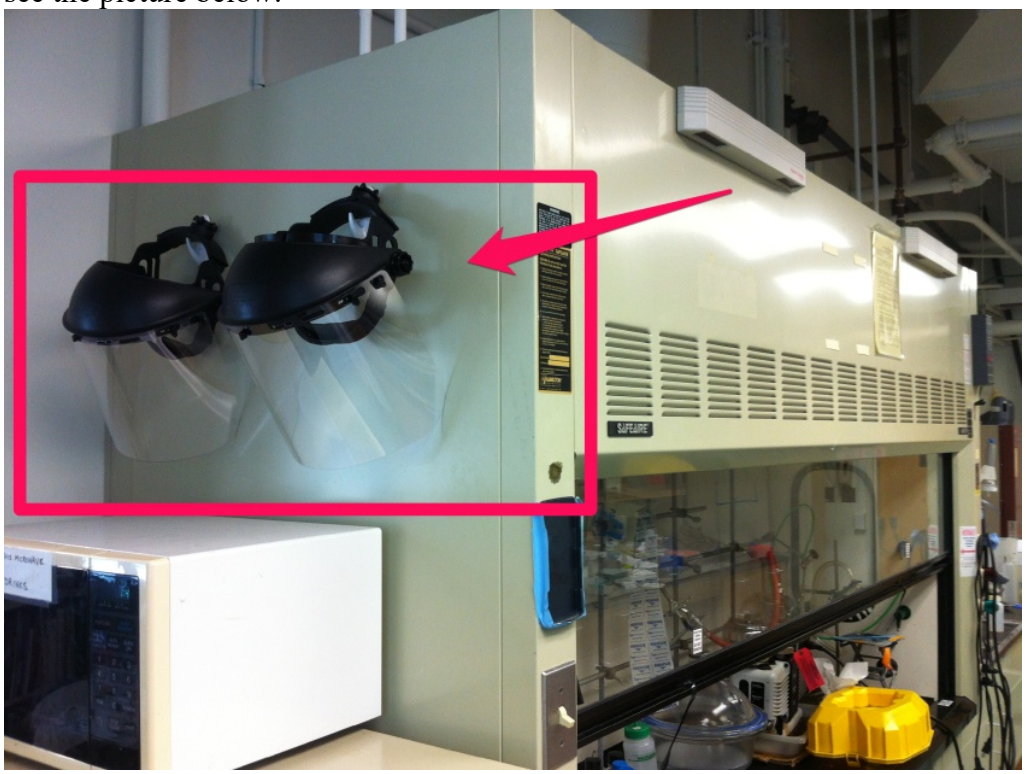
Communal PPE

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/labsfty/labrsc/lsglove.htm

On the following pages, you can find information and a **table with resistance data** for common laboratory gloves (nitrile, latex, and neoprene gloves are available in the lab or from the campus storerooms). This table is the 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

http://www.allsafetyproducts.com/glove-selection-chart-chemical-breakthrough-ratings.html; now at http://www.allsafetyproducts.com/asp-glove-selection-chart-chemical-break-through-times.html)

If you are working with **pyrophoric chemicals**, you must wear kevlar liners under neoprene gloves. No other gloves or glove combination is acceptable. A supply of both the liners and the gloves is available in the cupboards containing spare PPE in room 1032 or from the chemistry storeroom.

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.

Key: P=Poor, F=Fair, G=Good, E=Excellent, NR=Not Recommended

Chemical	Neoprene	Nitrile	Latex	PVC	Chemical	Neoprene	Nitrile	Latex	PVC
Acetaldehyde	E	P	F	NR	Kerosene	E	E	P	F
Acetic Acid	E	G	G	F	Lactic Acid	E	E	E	E
Acetone	G	NR	G	NR	Lauric Acid	E	E	G	F
Acetonitrile	F	NR	F	NR	Linoleic Acid	E	E	P	G
Ammonium Hydroxide<30%	E	E	G	E	Linseed Oil	E	E	P	E
Amyle Acetate	NR	E	F	P	Maleic Acid	E	E	P	G
Amyl Alcohol	P	G	G	NR	Methyl Acetate	G	P	P	NR
Aniline	G	NR	P	F	Methyl Alcohol	E	E	E	G
Animal Fats	E	E	P	G	Methylamine	G	E	E	E
Battery Acids	E	E	G	E	Methyl Bromide	NR	NR	NR	NR
Benzaldehyde	NR	NR	F	NR	Methylene Chloride	NR	NR	NR	NR
Benzene	NR	P	NR	NR	Methyl Cellusolve	E	F	P	-
Benzoly Chloride	NR	NR	P	NR	Methyl Ethyl Ketone (MEK)	G	NR	G	NR
Butane	F	E	P	P	Methylisobutyl Ketone	NR	P	F	NR
Butyl Acetate	NR	F	P	NR	Methyl Methacrylate	NR	P	P	NR
Butyl Alcohol	E	P	E	G	Mineral Oil	E	E	P	F
Butyl Cellusolve*	E	E	E	NR	Mineral Spirits	G	E	NR	F
Carbon Acid	E	P	P	G	Monoethanolamine	E	E	G	E
Carbon Disulfide	NR	NR	NR	NR	Morpholine	P	NR	G	NR
Carbon Tetrachloride	P	G	NR	NR	Muriatic Acids	E	G	G	G
Castor Oil	E	E	E	E	Naptha V.M & P.	G	E	NR	P
Cellosole Acetate	E	G	G	NR	Nitric Acid <30%	E	P	G	G
Cellosole Solvent	E	G	E	NR	Nitrile Acid 70%	G	NR	F	F
Chlorobenzene	NR	NR	NR	NR	Nitrile Acid Red Fuming	NR	NR	P	P
Chloroform	F	F	NR	NR	Nitrile Acid White Fuming	NR	NR	P	P
Chloronaphalens	NR	F	NR	NR	Nitrobenzene	NR	NR	P	NR
Chloroethene VG	NR	F	NR	P	Nitromethane	E	F	G	P
Chromic Acid	F	F	NR	G	Nitropropane	G	NR	E	NR
Citric Acid	E	E	E	E	Octyl Alcohol	E	E	G	F
Cottonseed Oil	E	E	P	G	Oleic Acid	E	E	P	F
Cresols	G	G	P	F	Paint Remover	G	G	F	P
Cutting Oil	E	E	F	P	Palmitic Acid	E	G	G	G
Cyclohexane	F	E	P	P	Pentachlorophenol	E	E	P	F
Cyclohexanol	E	E	P	G	Pentane	E	E	P	NR
Dibutyl Phthalate	F	G	P	G	Perchloric Acid 60%	E	E	P	E
Diethylamie	P	F	NR	NR	Potassium Hydroxide <50%*	E	G	E	E
Di-Isobutyl Ketone	P	E	P	P	Printing Ink	G	E	G	F
Dimethyl Formamide (DMF)	G	NR	E	NR	Propyl Acetate	P	F	P	NR
Dimethyl Sulfoxide (DMSO)	E	E	E	NR	Propyl Alcohol	E	E	E	F
Dicotyl Phthalate (DOP)	G	G	P	NR	Perchloroethylene	NR	G	NR	NR
Dioxane	NR	NR	NR	NR	Phenol	E	NR	G	G
Ethyl Acetate	F	NR	P	NR	Phosphoric Acid*	E	E	G	G
Ethyl Alcohol	E	E	E	G	Picric Acid	E	E	G	E
Ethylene Dichloride	NR	NR	P	NR	Propylene Oxide	NR	NR	P	NR
Ethylene Glycol	E	E	E	E	Rubber Solvent	G	E	NR	NR
Ethyl Ether	E	E	NR	NR	Sodium Hydroxide <50%	E	G	E	G
Ethylene Trichloride	P	P	P	NR	Stoddard Solvent	E	E	P	NR
Formaldehyde	E	E	E	E	Styrene*	NR	NR	NR	NR
Formic Acid	E	F	E	E	Sulfuric Acid 95%	F	G	NR	NR
Freon	G	F	NR	NR	Tannic Acid	E	E	E	E
Furfural	G	NR	E	NR	Tetrahydrofuran (THF)	NR	NR	NR	NR
Gasoline	P	E	NR	P	Toluene	P	G	NR	NR
Gylcerine	E	E	E	E	Toluene Di-Isocyanate (TDI)	NR	NR	P	P
Hexane	E	E	NR	NR	Trichlorethylene (TCE)	P	G	NR	NR
Hydraulic Fluid Petro. Based	F	E	P	G	Triricrestyl Phosophate (TCP)	F	E	G	F
Hydraulic Fluid Easter Based	P	P	P	P	Triethanolamine 85% (TEA)	E	E	G	E
Hydrazine 65%	E	E	G	E	Tung Oil	E	E	NR	F
Hydrochloric Acid*	G	E	E	E	Turbine Oil	E	G	P	F
Hydrofluoric Acid	G	E	E	E	Turpentine	G	E	P	P
Hydrogen Peroxide	E	E	E	E	Vegetable Oil	E	E	P	F
Hydroquinone	G	E	E	E	Xylene	P	G	NR	NR
Isobutyl Alcohol	E	E	E	F					
Iso-Octane	E	E	NR	P					
Isopropyl Alcohol*	E	E	E	G					

* ***Warning:*** Protective gloves and other protective apparel selection must be based on the user's assessment of the workplace hazards. Glove 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.

Chemical Resistance Chart

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/

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

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

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

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

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:

P2:	0.1uL – 2μL
P10:	0.5uL – 10μL
P20:	2uL – 20μL
P200 (trigger):	20uL – 200μL
P200 (general):	50uL – 200μL
P1000:	200uL – 1000μL

- 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 phones[2])
- 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

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

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 108).

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.

An online refresher course on hazardous waste is available (course code EH23) at the UC Learning Center:

https://www.learningcenter.ucsb.edu/

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.

Fire and explosion hazard: Under no circumstances may organic material (e.g. solvents) be added to the acid waste.

- We segregate halogenated and nonhalogenated solvent waste. The following solvents and mixtures containing them must only be added to the "Halogenated Solvent" waste:

  - Chloroform
  - Dichloromethane
  - Anything with "chloro", "bromo", or "fluoro" in the name – ask Kai if you are unsure.

- Segregate solids from liquids if feasible

- 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):

  - Strong oxidizers
  - Peroxide-forming chemicals
  - Cyanides
  - **Alkaline solutions of pH > 12.5**
  - Chemical carcinogen
  - Alkali metals and other water reactives
  - Unstable chemicals
  - Heavy metal solutions and salts
  - 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.

To electronically request pickup of the waste by EH&S, 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) must 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 red-lidded "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 may 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, place in the storage area for hazardous waste and request pickup by EH&S with their online form.

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
- □ 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://www.ehs.ucsb.edu/labsafety-chp/sec3/c/particularly-hazardous-substances)

- 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).

LCSS for ACRYLONITRILE

LABORATORY CHEMICAL SAFETY SUMMARY: ACRYLONITRILE

Substance	Acrylonitrile	
	(Vinyl cyanide, 2-propenenitrile, cyanoethylene, ACN)	
	CAS 107-13-1	
Formula	$H_2C = CH\text{-}CN$	
Physical Properties	Colorless liquid	
	bp 77 °C, mp -82 °C	
	Moderately soluble in water (7.3 g/100 mL)	
Odor	Mild pyridine-like odor at 2 to 22 ppm	
Vapor Density	1.83 (air = 1.0)	
Vapor Pressure	100 mmHg at 22.8 °C	
Flash Point	-1 °C	
Autoignition Temperature	481 °C	
Toxicity Data	LD_{50} oral (rat)	78 mg/kg
	LD_{50} skin (rabbit)	250 mg/kg
	LC_{50} inhal (rat)	425 ppm (4 h)
	PEL (OSHA)	2 ppm
	TLV-TWA (ACGIH)	2 ppm—skin
Major Hazards	Probable human carcinogen (OSHA "select carcinogen"); moderate acute toxicity; highly flammable.	
Hazard Class(es)	Highly flammable, toxic, potentially explosive, carcinogen	
Toxicity	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.

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 – SOP Use of Acrylonitrile

(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:

Name	Signature	Date

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 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 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).

LCSS for BENZENE

Substance	Benzene	
	(Benzol)	
	CAS 71-43-2	
Formula	C_6H_6	
Physical Properties	Colorless liquid	
	bp 80.1 °C, mp 5.5 °C	
	Slightly soluble in water (0.18 g/100 mL)	
Odor	"Paint-thinner-like" odor detectable at 12 ppm	
Vapor Density	2.7 (air = 1.0)	
Vapor Pressure	75 mmHg at 20 °C	
Flash Point	-11.1 °C	
Autoignition Temperature	560 °C	
Toxicity Data	LD_{50} oral (rat)	930 mg/kg
	LC_{50} inhal (rat)	10,000 ppm (7 h)
	PEL (OSHA)	1 ppm (3.2 mg/m^3)
	TLV-TWA (ACGIH)	10 ppm (32 mg/m^3)
	STEL (ACGIH)	5 ppm (16 mg/m^3)
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 – SOP Use of Benzene

(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:

Name	Signature	Date

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, $CHCl_3$) 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

Chemical Name	Hazard Class
Chloroform	Toxic (see LCSS for details)

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).

LCSS for CHLOROFORM

Substance

Chloroform
(Trichloromethane)
CAS 67-66-3

Formula

$CHCl_3$

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

LD_{50} oral (rat) 908 mg/kg
LD_{50} skin (rabbit) >20 g/kg
LC_{50} inhal (rat) 9937 ppm (47,702 mg/m^3; 4 h)
PEL (OSHA) 50 ppm (240 mg/m^3; ceiling)
TLV-TWA (ACGIH) 10 ppm (48 mg/m^3)

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 – SOP Use of Chloroform

(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:

Name	Signature	Date

SOP: Use of Dichloromethane

NOTE: Dichloromethane (aka methylene chloride, CH_2Cl_2, 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, CH_2Cl_2, 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).

LCSS for DICHLOROMETHANE

Substance	Dichloromethane (Methylene chloride; aerothene MM) CAS 75-09-2	
Formula	CH_2Cl_2	
Physical Properties	Colorless liquid bp 40 °C, mp -97 °C Slightly soluble in water (1.32 g/100 mL)	
Odor	Odor threshold 160 to 230 ppm	
Vapor Density	2.93 (air = 1.0)	
Vapor Pressure	440 mmHg at 25 °C	
Flash Point	Noncombustible	
Autoignition Temperature	556 °C	
Toxicity Data	LD_{50} oral (rat) LC_{50} inhal (rat) PEL (OSHA) TLV-TWA (ACGIH)	1600 mg/kg 88,000 mg/m^3; 30 min 500 ppm (8 h) 50 ppm
Major Hazards	Low acute toxicity; skin and eye irritant.	
Toxicity	Dichloromethane is classified as only slightly toxic by the oral and inhalation routes. Exposure to high concentrations of dichloromethane vapor (>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.	
Flammability and Explosibility	Noncombustible. Dichloromethane vapor concentrated in a confined or poorly ventilated area can be ignited with a high-energy spark, flame, or high-intensity heat source.	
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 – SOP Use of Dichloromethane

(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:

Name	Signature	Date

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

Chemical Name	Hazard
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://www.ehs.ucsb.edu/files/docs/hw/ethidium_bromide.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 – SOP Use of Ethidium Bromide

(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:

Name	Signature	Date

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).

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} inhal (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 – SOP Use of Formaldehyde

(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:

Name	Signature	Date

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://www.ehs.ucsb.edu/labsafety-chp/sec3/c/particularly-hazardous-substances)
"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://www.ehs.ucsb.edu/labsafety/fact-sheets

Reproductive Toxins

(see list at http://www.ehs.ucsb.edu/labsafety-chp/sec3/c/particularly-hazardous-substances)

Highly acute toxins

(see list at http://www.ehs.ucsb.edu/labsafety-chp/sec3/c/particularly-hazardous-substances)

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 chart of chemical resistance of common laboratory gloves is shown on page 39. Additional information on the selection of proper gloves can be found at

  http://www.ehs.ucsb.edu/labsafety-chp/sec2/selecting-proper-gloves

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 hood. **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: Use of Hexane(s)

Date of last revision to SOP: Oct. 2016 – Kai Ewert

PI approval of SOP:

_____ (C. R. Safinya) _____ Date

Scope of SOP

Use of hexane or hexanes (isomer mixture) as a solvent, an eluent for chromatography, and for cleaning

Compound information

n-Hexane is a neurotoxin and therefore must be handled with care and the appropriate safety precautions. See the toxicity information below for more information.

n-Hexane melts at –63.5 °C and boils at 61 °C.

Alternatives to Hexane(s)

The neurotoxicity of *n*-Hexane stands out over that of other alkanes because it is readily metabolized to 2,5-hexanedione. Thus, other simple alkanes can provide a much less toxic alternative. The table below lists three common alternatives and considerations for their use.

Alternative solvent	Drawbacks/considerations
Cyclohexane	High viscosity – significantly slows down/ increases pressure in flash chromatography High melting point (6.5 °C) – may limit use as a reaction medium Somewhat less powerful solvent (e.g. for vacuum grease) – may limit use for cleaning purposes, and as reaction or recrystallization solvent
Pentane	Low boiling point (36 °C) – may affect use as eluent for chromatography in solvent mixtures and other uses Less powerful solvent – limits use for cleaning purposes, and as reaction or recrystallization solvent Higher price

Heptane	Higher boiling point (98 °C) – may affect use as eluent for chromatography in solvent mixtures Higher price

→ CyH as a possible alternative (give drawbacks also though)

→ also pentane, heptane(s) as alternatives w/ drawbacks

safety precautions. See the toxicity information below for more information.

Approval and Training Required

Before using hexane(s), users must read the toxicity information below.
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

Chemical Name	Hazard Class
Hexane(s)	Neurotoxic (see below for details)

General precautions

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

Personal Protective Equipment

Users handling hexane(s) 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 required. Long pants or equivalent as well as closed-toe shoes are mandatory.

- **Lab gloves**

  Note that while nitrile and neoprene gloves are suitable for work with hexane(s) (see chart on pg. 39), **latex gloves are not**.

Engineering/Ventilation Controls

Hexane(s) and solvent mixtures containing hexane(s) must be handled in a **fume hood**. Use on the open bench is prohibited.

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

Special Chemical Handling, Storage, Cleanup and Disposal Requirements

- **Storage:**

  Hexane(s) must be stored in completely-sealed containers in one of the chemical storage cabinets underneath the fume hoods that are designated for solvent storage.

- **Spills/Cleanup:**

  Spills of hexane(s) 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 appropriate gloves (see above) when cleaning up a spill. “Barrier” type gloves are recommended for big spills. ll. 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 hexane(s) waste must be disposed of through EH&S like other chemical waste. Hexane(s) and solvent mixtures of them (unless containing chloroform or dichloromethane) should be disposed of by adding them to the "NON-HALOGENATED SOLVENTS" collection bottle and entering the amount added on the list provided. Hexane(s) must not be allowed to enter the sewer system or trash or be left to freely evaporate.

Additional Information

For additional information on hexane(s) and its hazards, see below (from https://pubchem.ncbi.nlm.nih.gov/compound/8058).

Substance

n-Hexane
(Hexane)
CAS 110-54-3

Used as a solvent, paint thinner, and chemical reaction medium.

Formula

C_6H_{14} or $CH_3[CH_2]_4CH_3$

Physical Properties

Clear colorless liquid with a petroleum-like odor

bp 61 °C, mp -63.5 °C
Less dense than water and insoluble in water. Vapors heavier than air.

Flash Point

-9 °F

Toxicity

1. Exposure Routes

   The substance can be absorbed into the body by inhalation, ingestion, skin and/or eye contact

2. Exposure Symptoms

   Irritation of eyes, nose, skin; nausea, headache; peripheral neuropathy: numb extremities, muscle weak; dermatitis; dizziness, drowsiness. lethargy. headache. nausea. weakness. unconsciousness; chemical pneumonitis (aspiration liquid)

3. Target Organs

   Eyes, skin, respiratory system, heart, central nervous system, peripheral nervous system

4. Acute Effects

   - Acute inhalation exposure of humans to high levels of hexane causes mild CNS depression. CNS effects include dizziness, giddiness, slight nausea, and headache in humans.
   - Acute exposure to hexane vapors may cause dermatitis and irritation of the eyes and throat in humans.
   - Acute animal tests in rats have demonstrated hexane to have low acute toxicity from inhalation and ingestion exposure.

5. Chronic Effects

   - Chronic inhalation exposure to hexane is associated with sensorimotor polyneuropathy in humans, with numbness in the extremities, muscular weakness, blurred vision, headache, and fatigue observed.
   - Rats, chronically exposed by inhalation, have exhibited neurotoxic effects.
   - Mild inflammatory, erosive, and degenerative lesions in the olfactory and respiratory epithelium of the nasal cavity have been observed in mice chronically exposed by inhalation. Pulmonary lesions have also been observed in chronically exposed rabbits.
   - The Reference Concentration (RfC) for hexane is 0.2 milligrams per cubic meter (mg/m3) based on neurotoxicity in humans and epithelial lesions in the nasal cavity in mice. The RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human

population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious noncancer effects during a lifetime. It is not a direct estimator of risk but rather a reference point to gauge the potential effects. At exposures increasingly greater than the RfC, the potential for adverse health effects increases. Lifetime exposure above the RfC does not imply that an adverse health effect would necessarily occur.

- EPA has medium confidence in the epidemiological study on which the RfC was based because the lowest-observed-adverse-effect level (LOAEL) in this study was based on neurotoxicology, and this endpoint is supported by numerous other subchronic inhalation studies in animals and by human occupational studies; medium confidence in the database because of the lack of long-term inhalation studies and appropriate reproductive studies; and, consequently, medium confidence in the RfC.
- EPA has not established a Reference Dose (RfD) for hexane.
- EPA has calculated a provisional RfD of 0.06 milligrams per kilogram body weight per day (mg/kg/d) based on neurological and reproductive effects in rats.

Toxicity Summary

CNS depression, convulsions, coma and death may follow acute exposures to large concentrations. Inhalation of n-hexane usually causes eye, nose, throat and respiratory irritation, which are rapidly reversible when exposure is discontinued. Symptoms are more severe is ingestion or inhalation are associated with exposure to other hydrocarbons which may potentiate the effects. Acute exposure to considerable concentrations of n-hexane may cause cough, wheezing, bloody frothy sputum, headache, dizziness, tachycardia and fever. Gastrointestinal symptoms may result. Respiratory system: slow and shallow respiration; aspiration of n-hexane may cause pulmonary edema and chemical pneumonia. Cardiovascular system: tachycardia and ventricular dysrhythmia. Central nervous system: vertigo, giddiness, CNS depression syndrome. In heavy exposures unconsciousness may result. Peripheral nervous system: chronic exposure may produce important peripheral neuropathy (motor sensory) and CNS abnormalities. Gastrointestinal tract: nausea, vomiting and anorexia. Hexane is poorly absorbed by the gastrointestinal system. Dermal absorption is very slow. Peak blood levels occur in less than 1 hour following inhalation or percutaneous exposure. N-Hexane has great affinity for high lipid content tissues and is rapidly metabolized to hydroxylated compounds before being converted to 2,5-hexanedione. Animal tests have been negative for teratogenic effects.

Flammability and Explosibility

Hexane is highly flammable. Vapor/air mixtures are explosive.

Documentation of Training – SOP Use of Hexane(s)

(signature of all users is required)

- Prior to conducting any work with hexane(s), 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:

Name	Signature	Date

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 Resources section for sources)

Chemical Name	Hazard Class

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://www.ehs.ucsb.edu/labsafety-chp/sec2/selecting-proper-gloves

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:

Name	Signature	Date

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.

All gas cylinders must be secured with at least one welded link chain unless they are in the process of being moved. Two chains, at 1/3 and 2/3 of the height of the cylinder, are better. 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 (e.g. plastic tubing)!

Additional Information

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

http://www.ehs.ucsb.edu/labsafety/fact-sheets

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: Nov. 2016 (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.).

Be prepared

- Spill prevention is much better than spill cleanup
- Know the location of fire extinguishers, emergency showers, and eyewash stations
- Know the location of PPE and spill kits

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 17, 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 – SOP Evacuated Glass Apparatus

(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:

Name	Signature	Date

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.

Documentation of Training – SOP Enclosed Glass with Cryogenic Cooling

(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:

Name	Signature	Date

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Appendix A: EH&S laboratory safety fact sheets

The following EH&S laboratory safety fact sheets are attached (accessed on 10/25/16 via http://www.ehs.ucsb.edu/labsafety/fact-sheets):

- Azides, Handling Organic
- Biological Waste Disposal
- Centrifuge
- Chemical Storage
- Ethidium Bromide (from http://www.ehs.ucsb.edu/files/docs/hw/ethidium_bromide.pdf)
- Housekeeping Guide for labs
- Liquid Waste Collection in a Biosafety Cabinet
- Power Failures Guide
- Refrigerator & Freezers in Lab
- Seismic Hazard Reduction
- Time-Sensitive Chemicals

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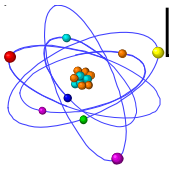
LABORATORY SAFETY FACT SHEET #26



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.'[1] 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.[2]

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:

NaN_3:

- Azide ion has a similar toxicity as that of cyanide ion (LD_{50} = 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.[1] 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.

$$\frac{N_C + N_O}{N_N} \geq 3 \qquad \text{(eq. 1)}$$

- 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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[1]. Kolb, H.C.; Finn, M.G.; Sharpless, K.B. *Angew. Chem. Int. Ed.* **2001**, *40*, 2004-2021.
[2]. Brase, S.; Gil, C.; Knepper, K.; Zimmerman, V. *Angew. Chem. Int. Ed.* **2005**, *44*, 5188-5240. And all references therein.
[3]. Smith, P.A.S. Open-Chain Nitrogen Compounds, vol. 2, Benjamin, New York, 1966, 211-265.
[4]. Feldman, A.K.; Colasson, B.; Fokin, V.V. *Org. Lett.* **2004**, *6*, 3897. Thibault *et al.* manuscript in preparation

LABORATORY SAFETY FACT SHEET #20

Guidelines for Biological Waste Disposal

Biological waste is any material that contains or has been contaminated by a biological agent. Biological waste includes, but is not limited to, Petri dishes, pipettes, tissue culture flasks, syringes, needles, and cell culture media. All biological waste (noninfectious and infectious) generated during laboratory research must be deactivated by autoclaving or chemically treated before disposal.

SHARPS CONTAMINATED WITH BIOLOGICAL WASTE

Sharps are items that are capable of puncturing, cutting or abrading the skin, e.g., needles, scalpel blades, slides and cover slips. Sharps are deactivated by autoclaving. Place sharps in a container that is red, rigid, puncture resistant, leak-proof and labeled with the biohazard symbol.

1. Autoclave your sharps container for a minimum of 30 minutes at 121°C and 15psi
2. Log the autoclave run duration, quantity of processed waste, date, and operator
3. Label the sharps container with the words “autoclaved”
4. Deface any biohazard symbols
5. Dispose of the container:
    a. Submit an EH&S online *Waste Pickup Request*. Note on the request that the container has been autoclaved.
    b. Leave your autoclaved container at Bio II 4106, LSB 2204, or LSB 4218, where it will be picked up without a request.

LIQUID WASTE

Liquid wastes, e.g., cell culture media and serum, are deactivated either by autoclaving or chemical disinfection. Most liquid wastes can be deactivated with bleach.

1. Chemically disinfect with a 1:10 final dilution (vol/vol) of household bleach
2. Swirl flask contents and allow a contact time of 30 minutes
3. Pour down a sink drain connected to the campus sewage system and flush the plumbing with an excess of water

- Alternatively, liquid waste may be autoclaved for 30 minutes at 121°C and 15psi

SOLID WASTE

Solid biological waste, e.g., pipettes, tissue culture flasks, and multiple well plates, is typically deactivated by autoclaving.

1. Collect solid biological waste directly into autoclavable bags
2. Tie a knot using the upper third of the bag and affix heat sensitive indicator tape near the knot
3. Use a secondary container for all autoclave bags until disposal
4. Ensure the autoclave operates for 30 minutes at 121°C and 15psi
5. Log the autoclave run duration, quantity of processed waste, date, and operator
6. Deposit the bag in the red-lidded totes designated for laboratory waste

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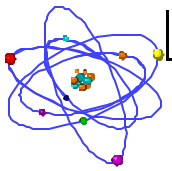
LABORATORY SAFETY FACT SHEET #19



Centrifuge Safety

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

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LABORATORY SAFETY FACT SHEET #7

SAFE STORAGE OF CHEMICALS

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

Flammables ***Corrosives*** ***Oxidizers*** ***Carcinogens*** ***Water Reactives*** ***Toxics*** ***Pyrophorics***

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/labrsc/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

Acetone	Ethyl Acetate	Isopropyl Alcohol	Toluene
Benzene	Ethyl Ether	Methanol	Xylene
Cyclohexane	Gasoline	Propanol	
Ethanol	Hexane	Tetrahydrofuran	

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

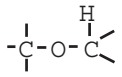
OXIDIZERS-react violently with organics.

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

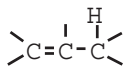
Storage Precautions:
⇨Keep away from flammables, organic solvents, and other combustible materials (i.e. paper, wood, etc.).
⇨Keep away from reducing agents.
⇨Store in a cool, dry place.

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

Ethers and acetals with α-hydrogen


(e.g. ethyl ether, tetrahydrofuran)

Alkenes with allylic hydrogen


(e.g. cyclohexene)

For a more complete list of these materials visit our website at
http://www.ehs.ucsb.edu/units/labsfty/labrsc/lsflamable.htm#formers

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.

Some finely divided metals
Some organoaluminum compounds ($LiAlH_4$, $Al(CH_3)_3$)
Silane
●Phosphorus, Yellow
  ●Phosphorus, yellow should be stored and cut under water

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

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

Solids	*Liquids*
Calcium Carbide	Phosphorus Trichloride
●Lithium	Thionyl Chloride
Magnesium	
●Potassium	
●Sodium	

  ●Lithium, Potassium, and Sodium should be stored under Kerosene or Minerial Oil

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

HIGHLY TOXICS, CARCINOGENS, REPRODUCTIVE TOXINS

These chemicals can be very hazardous by themselves, or in combination with other chemicals. If they are easily inhaled, (gases and volatile liquids) then they are particularly hazardous. Suspected human carcinogens should also be stored as highly toxic. Lists of these materials are provided on our website:
http://www.ehs.ucsb.edu/units/labsfty/labrsc/chemistry/lschem.htm

Gases - Store in a gas cabinet or other ventilated cabinet

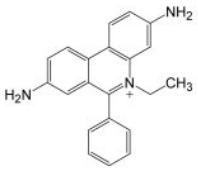
Chlorine	Fluorine
Hydrogen chloride	Nitric Oxide

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

Formaldehyde	Carbon disulfide	Mercury
Nickel carbonyl	Cyanide solutions	

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

Cyanides, Salts of
Sulfides, Salts of



Ethidium Bromide Treatment and Disposal

Ethidium bromide is a commonly used stain for identifying nucleic acids in electrophoresis gels. It is known to be toxic and mutagenic and may be fatal if swallowed and harmful if inhaled or absorbed through the skin.

Before working with a chemical, know all of the potential hazards and safety precautions by reviewing the material safety data sheet (MSDS). Always wear personal protective equipment including gloves, goggles and a lab coat when working with ethidium bromide. Also, protect yourself from any UV sources that you may use when visually inspecting for ethidium bromide.

Waste Management Procedures

Gels, filters, and other solids containing ethidium bromide *must* be managed as a hazardous chemical waste and disposed of through EH&S. The waste must be double bagged, labeled with an EH&S hazardous waste label and placed in secondary containment. Do not use a biohazardous waste bag to package ethidium bromide waste.

Ethidium bromide solutions *cannot* be disposed of down the sanitary sewer. Ethidium bromide solutions must be treated as part of the experimental protocol or managed as a hazardous chemical waste and disposed of through EH&S.

Charcoal filtration treatment is a simple and effective method for removing ethidium bromide from electrophoresis buffers through a bed of activated charcoal. Prior to drain disposal of the filtered non-hazardous solution, check for fluorescence by using a UV light to ensure complete removal of the ethidium bromide. You can build your own filter or purchase one. When the filter is saturated, the charcoal must be managed as a hazardous chemical waste and disposed of through EH&S.

Charcoal filtration treatment of ethidium bromide solutions must follow the steps outlined in AB966 Benchtop Treatment:

- The laboratory hazardous waste treated is less than 5 gallons or 18 kg per batch whichever is greater.
- The laboratory hazardous waste is treated at the point of generation.
- Treatment is conducted within 10 calendar days of accumulation.
- The person performing the treatment has knowledge of the laboratory hazardous waste being treated, including knowledge of the procedure that generated the waste, and has received hazardous waste training.

Please note that oxidation of ethidium bromide with bleach is not an acceptable destruction technique and must not be used.

Alternatives To Ethidium Bromide

There are less hazardous and environmentally friendly alternatives to ethidium bromide. For more information visit the websites of the products listed below.

Company	Product	Website
Invitrogen	SYBR Safe	http://probes.invitrogen.com/products/sybrsafe/
Biotium	GelRed / GelGreen	http://www.biotium.com/
AMRESCO	EZ Vision DNA Dye	http://www.amresco-inc.com/

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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)

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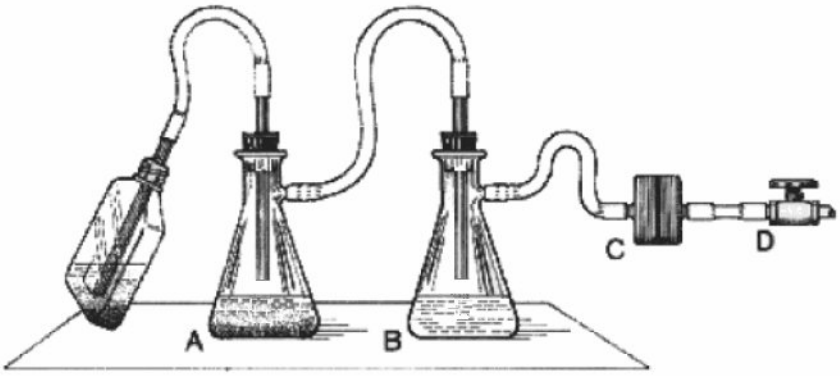
Liquid Waste Collection in a Biosafety Cabinet

Protection of Vacuum Systems Used in Tissue Culture Work

The recommended method to protect a house vacuum system during aspiration of infectious fluids is shown below. The left suction flask (A) is used to collect contaminated fluid into a suitable decontamination solution; the right flask serves as a fluid overflow collection vessel. Flask (B) also minimizes splatter in the vacuum line. An in-line HEPA filter (C) is used to protect the vacuum system (D) from aerosolized microorganisms.



This schematic is from Biosafety in Microbiological and Biomedical Laboratories, 5th edition, Office of Health and Safety, Centers for Disease Control and Prevention, 1600 Clifton Road N.E., Mail Stop F05 Atlanta, Georgia 30333, USA; http://www.cdc.gov/biosafety/publications/bmbl5/

Example HEPA filter for vacuum line 	Whatman HEPA-Vent Filter Assure sterile air for mixing, filling, storing, fermenting, and transporting with this Whatman filter. Glass fiber filter is treated to be mildly hydrophobic; repels moisture, prevents bacterial growth; 0.3µm particle retention unaffected by autoclaving. Bidirectional flow. 16cm^2 filter area. Inlet/Outlet: 1/4-3/8 in. tapered hose barb Whatman No.: 6723-5000	Fisher Scientific: 09-744-79

If a glass flask is used at floor level, place it in a secondary plastic container to prevent breakage.

Bleach Disinfection of Contaminated Liquid Waste

You can treat most liquid waste with bleach. To treat liquid waste with a high organic load (blood, body fluids, spent cell culture media):

1. Mark 1000 ml accurately on the side of a 2000 ml Erlenmeyer vacuum flask
2. Add 100 ml of fresh household bleach to the flask
3. Collect contaminated liquids, swirl the flask periodically
4. When the 1000 ml mark is reached, stop adding material, swirl the flask, leave for at least 30 minutes or let sit overnight
5. Discard treated liquid in the sink and follow by flushing with at least four liters of rinse water. Discard treated liquid at least once a week.

LABORATORY SAFETY FACT SHEET # 32

Be Prepared for Power Failures

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

Emergency Lighting and Power

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

Data Backup

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

Power Failure in Laboratories

Before Power Fails

- Be sure the after-hours contact information on your lab door placard is up-to- date. Ideally, these individuals should be knowledgeable about all of the laboratory's major operations, particularly those that are hazardous/sensitive to power outages.
- Put essential equipment on emergency power circuits if available. Contact Facilities Management - they may be able to provide additional service capacity, along with a small number of portable units that may be available to keep critical operations going during power interruptions.
- Make a list of equipment that must be reset or restarted once power returns. Keep instructions for doing so in a nearby place. Hazardous processes that operate unattended should be programmed to shut down safely during a power failure and not restart automatically when power returns.
- Identify an emergency source of dry ice if you have items that must be kept cold. Refrigerators and freezers will maintain their temperature for several hours if they are not opened. **Do not use dry ice in walk-in refrigerators or other confined areas** because hazardous concentrations of carbon dioxide gas will accumulate.

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 a explosion. Before purchasing a new refrigerator/freezer, or using an existing one, consider whether chemicals will be used for storage in this unit.

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

I. FLAMMABLE MATERIAL STORAGE REFRIGERATORS/FREEZERS:

These have no internal electrical components which could trigger an explosion inside the unit. These must always be used for storage of volatile materials.

II. EXPLOSION-PROOF REFRIGERATORS/FREEZERS :

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

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

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

For further information contact EH&S Laboratory Safety Specialist at X4899

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Laboratory Safety Fact Sheet #1

Nonstructural Seismic Hazard Reduction Policies

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

Campus policies:

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

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

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

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

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

Recommended practices:

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

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

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

References:

University Policy on Seismic Safety, rev. 5/2/94
University Policy on Nonstructural Seismic Hazard Reduction, Policy 5445, rev. 6/1/95

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Time-Sensitive Chemicals

7/26/2005

Prepared by UCSB Environmental Health & Safety

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.

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Appendix B: Chemical Resistance of Common Lab Gloves

This information has been integrated into the CHP and can now be found on page 39.

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Appendix C: MRL Emergency Operations Plan

This appendix reproduces the MRL Emergency Operations Plan (also Emergency Action Plan & Fire Prevention Plan), accessed on 2/22/18 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.

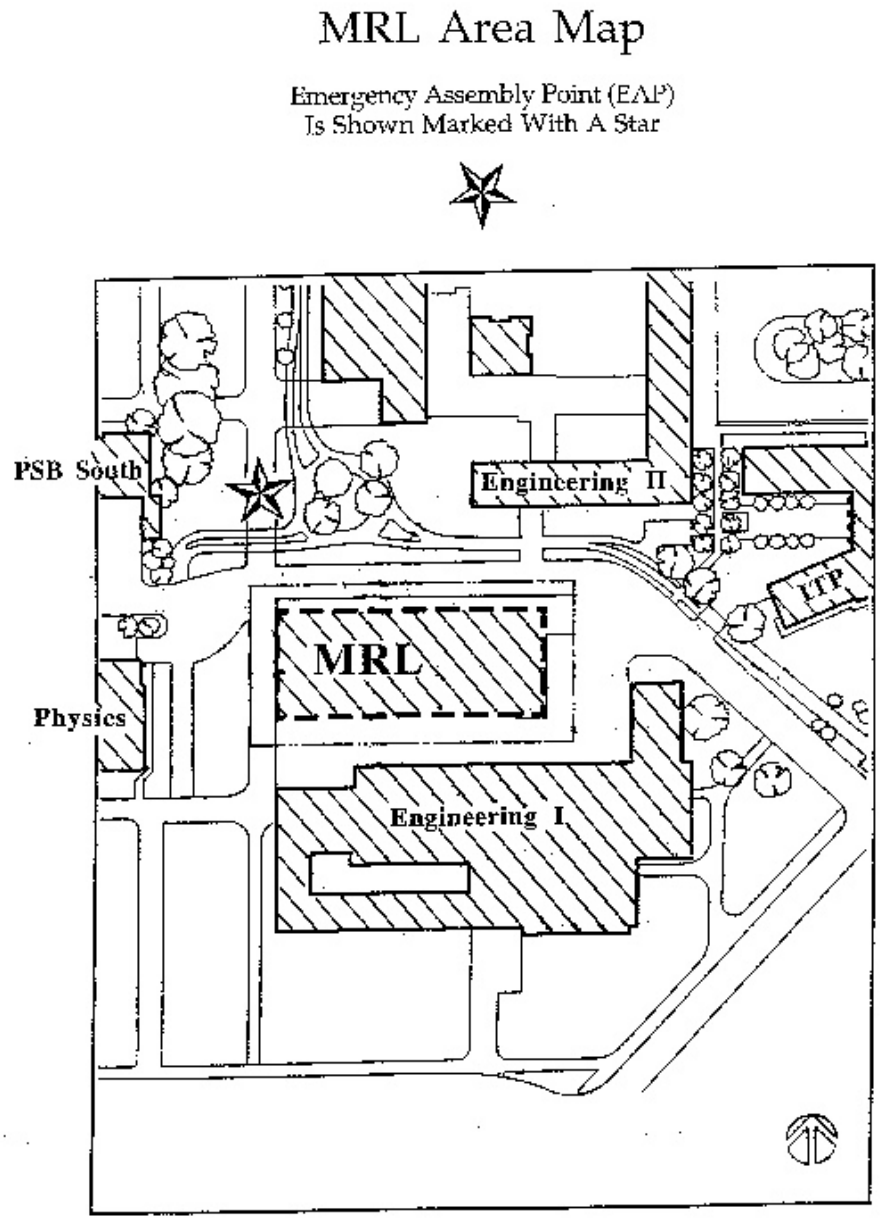
Medical Emergency

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/**

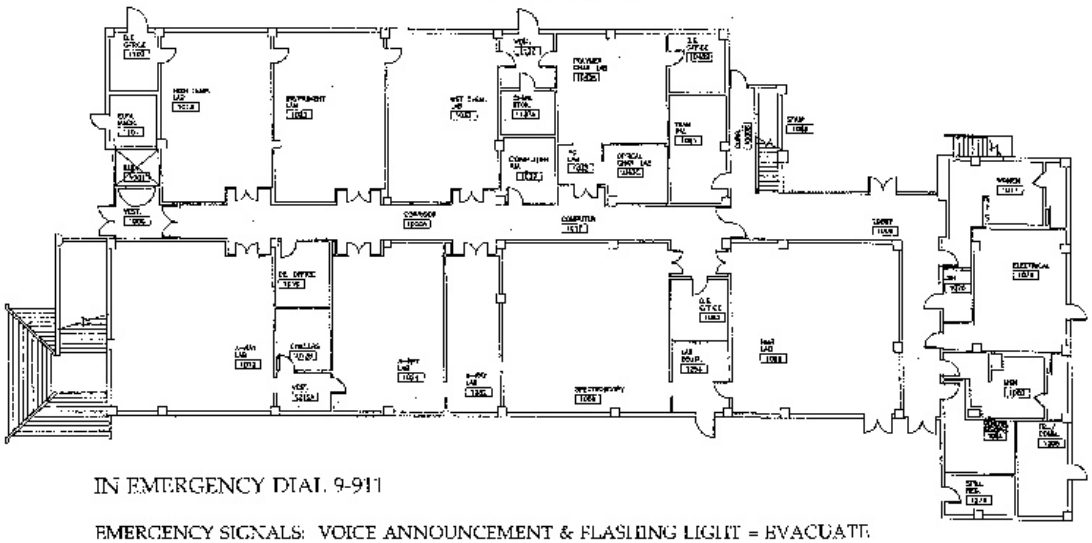
MRL Area Map


MRL Area Map
Emergency Assembly Point (EAP)
Is Shown Marked With A Star
PSB South
Engineering II
ITP
MRL
Physics
Engineering I

Emergency exit plans for floors 1 through 3

EMERGENCY EXIT PLAN

MRL FIRST FLOOR



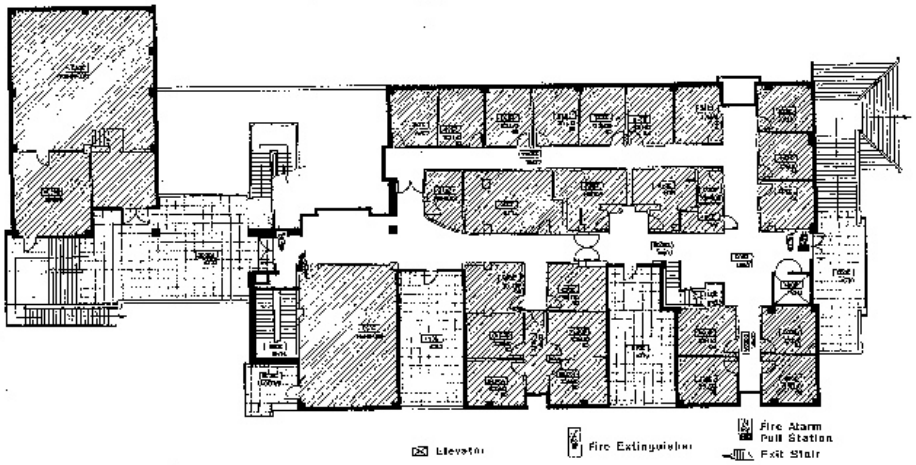
IN EMERGENCY DIAL 9-911

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



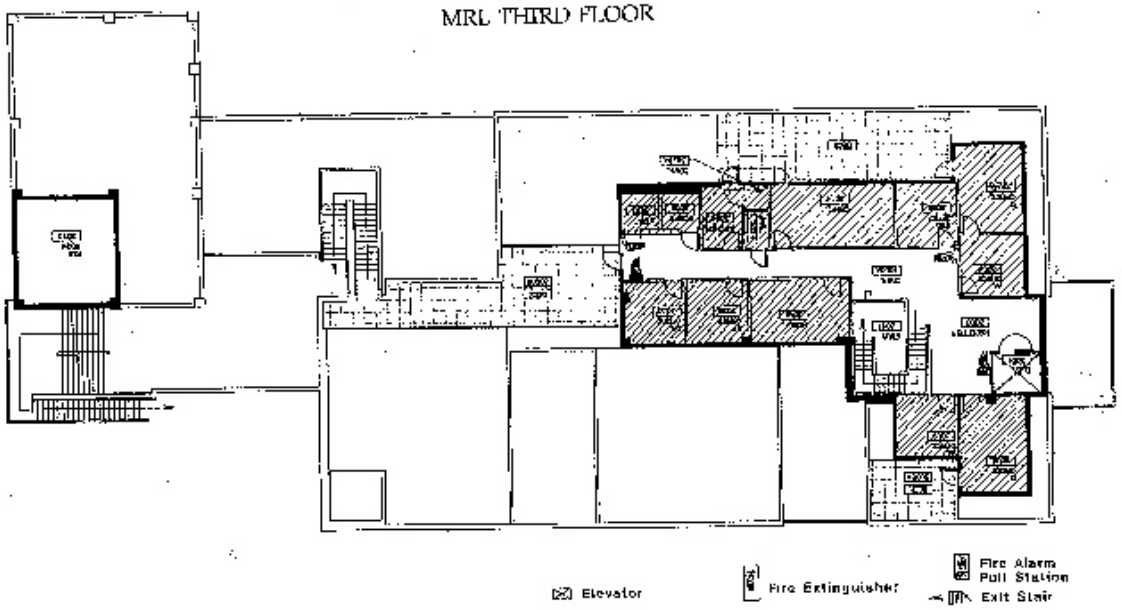
IN EMERGENCY DIAL 9-911

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 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 2/22/2018 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 a unsafe situation is discovered it should be reported to the Laboratory Development Engineer, the Principal Investigator, and/or the HCC.

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

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

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

Procedures for Investigating Injuries and Illness

Any injury to an employee requires the following response:

1. Any employee injured on the job must report the injury to their supervisor, the MSO, or the HCC as soon as possible after the injury.

2. The HCC is to investigate the nature and cause of the injury.

3. EH&S may also investigate the nature and cause of the injury.

4. The "Employee Claim for Worker's Compensation Benefits Form" must be given or mailed to the injured employee within one working day from the time when the injury is reported to the employer. The employee has the option of filling out and returning this form to the MSO.

5. The injured employee's supervisor, usually the Principal Investigator or the MSO, is required to complete the "Report of Injury to Employee Form" within 24 hours of the injury and give it to the MSO.

6. The MSO will forward all injury report forms to the Campus Business Services Office and EH&S as specified in the Worker's Compensation Claim Report Procedure.

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

Procedures for Correcting Unsafe or Unhealthy Conditions

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

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

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

Safety & Health Training

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

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

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 2/22/2018 via

http://www.ehs.ucsb.edu/files/docs/ls/Lab_Self_InspectionChecklist_web_August_2016.pdf

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Laboratory Self-Inspection Checklist

revised August 2016

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

- Under California law (OSHA), supervisors (PIs) are required to: *"… include procedures for identifying and evaluating work place hazards including scheduled periodic inspections to identify unsafe conditions and work practices."*

- Beyond any regulatory requirements, doing regular self-inspections will clearly increase the level of safety in your area.

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

Hazardous Waste

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

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

3. Are all hazardous waste containers labeled with the official UCSB Hazardous Waste label?


PLACE ON CONTAINER WHEN FIRST DROP OF WASTE IS GENERATED
UCSB HAZARDOUS WASTE

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

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

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

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

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

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

Chemical Safety

1. *Chemical Hygiene Plan* (CHP)

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

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

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

4. Are stored chemicals segregated according to hazard classification/compatibility (acids, bases, flammables, oxidizers, water 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. Check chemical stocks regularly for materials that can become dangerously unstable over time and dispose of via EH&S. Links to descriptions of these materials can be found at:
http://www.ehs.ucsb.edu/files/docs/ls/factsheets/Time_sensitive_materials.pdf

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

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

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

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

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

Note: Some lab buildings have a designated "spill closet" – generally keyed to graduate master key.

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 ("hydrostatic 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.
☐ Ensure gas tubing is appropriate for the material being used.
☐ Do not use Teflon tape or "pipe dope" on CGA connections unless specified by the equipment manufacturer. Particularly avoid this with oxygen systems.
☐ Use of large cylinders of highly toxic gases must be reviewed/approved (contact 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. Lab refrigerators

☐ Are refrigerators for storing flammables clearly posted with signage indicating they are safe for such storage? (e.g. "desparked", "lab-safe", "explosion-proof", "flammable storage").
☐ Are refrigerators that are **NOT** designed for flammables storage clearly marked as such? (this is very important to prevent a potential explosion)
☐ Are all chemical storage refrigerators marked with "*No Food*" labels?
☐ Refrigerators in labs utilized for food or drinks should be marked "*Food Only/No Chemicals*?"

7. Is the location of manuals/instructions for each piece of equipment known?

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

9. **Solvent stills with water-reactive drying agents**

- Are solvent stills clearly labeled with the solvent name and drying reagent?

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

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

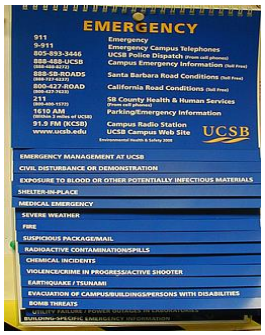
- **Quenching Solvent Stills -**The quenching of used still-pots is potentially dangerous but can be done safely if appropriate precautions are taken. "See EH&S Fact Sheet on still quenching"

· ***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.

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

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


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

WHAT TO LOOK FOR IN YOUR LAB:
No hazardous materials stored on floor and away from the edge of benches
Aisles, secondary exits and corridors kept clear
Keep lab benches and hoods as uncluttered as possible.
Glassware that is scattered on benches and out in the open clutters working areas, is easily broken, will not stay clean, and, if dirty, may be confused for clean glassware and could potentially negate any viable research.

11. Lab doors are fire-rated and therefore cannot be propped open with a wedge or other device. Discontinue use of these, or SB County Fire may confiscate them and cite the University.

12. Secure your highly hazardous materials, e.g. highly toxic gas, radiation, select biological agents. Ensure the lab door(s), freezers, refrigerators, storage cabinets, etc. with these materials are locked whenever the lab is unattended.

Electrical Safety

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

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

3. Are employees instructed **not** to use extension cords in place of permanent wiring (use allowed if only on a temporary, immediate, basis)? Have permanent receptacles installed for long-term electricity needs.

- Ensure extension cords are 14-gauge (heavy duty) at a minimum, and **temporarily** servicing only one appliance or fixture?
- Ensure extension cord is plugged directly into receptacle. Extension cords should never be used plugged end-to-end; use the proper length cord.

- If extension cords are used, ensure cords are not running through walls, ceiling or doors?

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

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

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

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

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

9. Are high voltage control panels and access doors posted?

Seismic Safety

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

   Visit web links for securing lab instruments & appliances:

   Earthquake Restraint System for Optical Tables

   Securing Your Stuff

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

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

Administrative

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

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

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

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

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

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

Any questions, please call X-8243.

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Appendix F: LHAT assessments for the Safinya Labs

This appendix contains relevant parts of the certified, LHAT-generated laboratory hazard assessments for the three Safinya labs, accessed on 2/22/2018 via

https://ehs.ucop.edu/lhat/

As a lab member, you can use the above link at any time to view the current and full assessments after you log in. Therefore, these assessments are not provided in the hardcopy version of the CHP.

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Main MRL labs Assessment

Certified Laboratory Hazard Assessment (certified on 11/27/2017)

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.

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

Building	Room
Materials Research Lab	1012
Materials Research Lab	1012B
Materials Research Lab	1024
Materials Research Lab	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.

Recommended PPE

Personal Protective Equipment	Custom Laboratory Activity PPE	Shared Protective Equipment

Personal Protective Equipment	Custom Laboratory Activity PPE	Shared Protective Equipment
• Flame resistant lab coat (NFPA 2112) • Lab coat * • Chemical splash goggles • Safety glasses • Full-length pants or equivalent • Closed toe/heel shoes * = Not displayed on voucher.		• Chemical-resistant gloves • Chemical-resistant apron • Thermal protective gloves (impermeable insulated gloves for liquids and steam) • Cryogenic protective gloves • Possibly warm clothing • Disposable gloves • Optical density and wavelength-specific safety glasses based on individual beam parameters • Flame resistant inner gloves or glove liners • Cut-resistant gloves • Impermeable or chemical resistant gloves • Face shield • Shoe covers • Flame-resistant (FR) outer gloves • Chemical-resistant outer gloves

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.
- Work with liquid pyrophoric chemicals outside of an inert atmosphere glove box requires flame resistant inner gloves and chemical resistant outer gloves.
- Flame resistant inner gloves are recommended when quenching water reactive chemicals that release flammable gases.

All Laboratories — Complete ✔

Response	Lab Activity
○ Yes ◉ No	This laboratory has been designated and posted as free of chemical, physical, biological, radiological, laser, and non-ionizing hazards. Skip all other sections.

Chemical Hazards — Complete ✔

☐ I certify that all activities listed in the Chemical Hazards section below are NOT conducted in this laboratory.

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
◉ Yes ○ No	C1. Working with hazardous chemicals (solid, liquid, or gas)	• Eye or skin damage • Potential poisoning through skin contact	• Lab coat • Chemical-resistant gloves • Chemical splash goggles for larger volumes • Safety glasses	In adjacent area: • Lab coat • Safety glasses
◉ Yes ○ No	C2. Working with hazardous liquids or other materials which create a splash hazard	• Eye or skin damage • Poisoning	• Lab coat • Chemical splash goggles • Chemical-resistant gloves • Chemical-resistant apron should be considered • Face shield should be considered	In adjacent area: • Lab coat • Safety glasses
◉ Yes ○ No	C3. Working with small volumes (<= 4L) of corrosive liquids or solids	• Eye or skin damage • Low probability for a splash hazard	• Lab coat • Chemical-resistant gloves • Safety glasses	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	C4. Working with large volumes (> 4L) of corrosive liquids or solids	• Eye or skin damage • Low probability for a splash hazard	• Lab coat • Chemical splash goggles • Chemical-resistant gloves • Chemical-resistant apron	In adjacent area: • Lab coat • Chemical splash goggles
◉ Yes ○ No	C5. Working with small volumes (<= 1L) of flammable solvents/materials when no reasonable ignition sources are present	• Eye or skin damage • Potential poisoning through skin contact	• Lab coat • Chemical-resistant gloves • Safety glasses	In adjacent area: • Lab coat • Safety glasses
◉ Yes ○ No	C6. Working with large volumes (> 1L) of flammable solvents/materials	• Potential poisoning through skin contact • Major fire • Major skin or eye damage	• Chemical-resistant gloves • Flame resistant lab coat (NFPA 2112) • Safety glasses • Flame-resistant outer gloves should be considered	In adjacent area: • Lab coat • Safety glasses

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	C7. Working with any quantity of flammable solvents/materials when there are reasonable ignition sources present; or working in areas where flammable concentrations of vapors or gas may be present	• Potential poisoning through skin contact • Major fire • Major skin or eye damage	• Chemical-resistant gloves • Flame resistant lab coat (NFPA 2112) • Safety glasses • Flame-resistant outer gloves highly recommended	All personnel in laboratory room; • Flame resistant lab coat (NFPA 2112) • Safety glasses
○ Yes ◉ No	C8. Working with Category 1 or 2 acutely toxic chemicals	• Spills, splashes, ingestion, inhalation, absorption • Chemicals pose a high level of immediate health risk	• Lab coat • Chemical-resistant gloves • Safety glasses • Chemical protective apron for H310	In adjacent area: • Lab coat • Safety glasses
◉ Yes ○ No	C9. Working with known or suspect human carcinogens	• High hazard cancer-causing agents • Spills, splashes, ingestion, inhalation, absorption	• Lab coat • Chemical-resistant gloves • Safety glasses	In adjacent area: • Lab coat • Safety glasses
◉ Yes ○ No	C10. Working with reproductive hazard chemicals (including reproductive toxicants and germ cell mutagens)	• Agents that affect reproductive capabilities, cause mutation and adversely affect fetal development • Spills, splashes, ingestion, inhalation, absorption	• Lab coat • Chemical-resistant gloves • Safety glasses	In adjacent area: • Lab coat • Safety glasses

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
◉ Yes ○ No	C11A. Working with pyrophoric chemicals (or reagents)	• Severe skin and eye damage • Fire	• Flame resistant lab coat (NFPA 2112) • Safety glasses • Face shield should be considered • Chemical-resistant outer gloves • Flame resistant inner gloves or glove liners	All personnel in laboratory room; • Flame resistant lab coat (NFPA 2112) • Safety glasses
◉ Yes ○ No	C11B. (New Question) Working with substances which in contact with water emit flammable gases	• Severe skin and eye damage • Fire	• Chemical-resistant gloves • Flame resistant lab coat (NFPA 2112) • Safety glasses • Face shield should be considered • Flame resistant inner gloves or glove liners	All personnel in laboratory room; • Flame resistant lab coat (NFPA 2112) • Safety glasses
○ Yes ◉ No	C12. Working with potentially explosive chemicals	• Splash, detonation, flying debris • Eye or skin damage • Fire	• Chemical-resistant gloves • Flame resistant lab coat (NFPA 2112) • Blast shield should be considered • Safety glasses • Face shield should be considered	All personnel in laboratory room; • Chemical splash goggles • Flame resistant lab coat (NFPA 2112) • Safety glasses
○ Yes ◉ No	C13. Working with Category 2 or higher engineered nanomaterials	• Inhalation, exposure, dermal exposure	• Lab coat • Chemical-resistant gloves • Safety glasses	All personnel in laboratory room; • Lab coat • Safety glasses
◉ Yes ○ No	C14. Minor chemical spill cleanup	• Respiratory damage • Eye or skin damage	• Lab coat • Chemical-resistant gloves • Chemical-resistant apron • Safety glasses • Shoe covers	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	C15. Major chemical spill cleanup	• Multiple hazards	• Call EH&S for assistance	All personnel in laboratory room must evacuate lab

Physical Hazards

Complete ✔

☐ I certify that all activities listed in the Physical Hazards section below are NOT conducted in this laboratory.

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
◉ Yes ○ No	P1. Working with cryogenic liquids	• Major skin, tissue, or eye damage	• Lab coat • Chemical splash goggles for larger volumes • Safety glasses • Face shield should be considered • Cryogenic protective gloves	In adjacent area: • Lab coat • Safety glasses
◉ Yes ○ No	P2. Working with very cold equipment, samples, or dry ice	• Frostbite, hypothermia	• Lab coat • Safety glasses • Cryogenic protective gloves • Possibly warm clothing	N/A
◉ Yes ○ No	P3. Removing sealed vials from liquid nitrogen	• Vials may explode upon rapid warming • Cuts to face/neck and frostbite to hands	• Lab coat • Safety glasses • Face shield should be considered • Cryogenic protective gloves	In adjacent area: • Lab coat • Safety glasses
◉ Yes ○ No	P4. Working with scalding liquids or hot equipment (e.g., autoclave, water bath, oil bath)	• Eye or skin damage • Burns	• Lab coat • Chemical splash goggles for larger volumes • Safety glasses • Thermal protective gloves (impermeable insulated gloves for liquids and steam)	N/A
◉ Yes ○ No	P5. Glassware washing	• Lacerations, chemical splash	• Lab coat • Chemical-resistant gloves • Safety glasses	N/A

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	P6. Working with loud equipment, noises, sounds, alarms, etc.	• Potential ear damage and hearing loss	• Hearing protection (consult EH&S for SNR factor needed)	In adjacent area: • Hearing protection (consult EH&S for SNR factor needed)
○ Yes ◉ No	P7. Working with a high-powered sonicator	• Ear damage, tissue damage	• Lab coat • Safety glasses • Hearing protection (consult EH&S for SNR factor needed) • Disposable gloves	In adjacent area: • Hearing protection (consult EH&S for SNR factor needed)
◉ Yes ○ No	P8. Working with a centrifuge	• Imbalanced rotor can lead to broken vials, cuts, exposure, projectiles	• Lab coat • Safety glasses • Disposable gloves	N/A
◉ Yes ○ No	P9. Working with sharps (e.g. needles, razor blades and broken glass)	• Exposure • Cuts	• Lab coat • Cut resistant gloves should be considered • Safety glasses	N/A
◉ Yes ○ No	P10. Working with an apparatus containing materials under pressure or vacuum	• Eye or skin damage • Projectiles	• Lab coat • Chemical-resistant gloves • Chemical-resistant apron (for high risk activities) • Safety glasses • Face shield should be considered (for high risk activities)	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	P11. Working with a microtome	• Cuts, pinch and exposure	• Lab coat • Cut-resistant gloves • Safety glasses	N/A

Biological Hazards

Complete ✔

☑ I certify that all activities listed in the Biological Hazards section below are NOT conducted in this laboratory.

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	B1. Working with human or non-human primate blood, body fluids, tissues, cells or other potentially infectious material (OPIM) which may contain human bloodborne pathogens (BBP)	• Sharps injuries • Exposure to infectious material	• Barrier lab coat impervious to fluids • Disposable gloves • Eye and mucous membrane protection (as appropriate for operations)	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	B2. Working with microbial agents (bacteria, virus, parasites, yeast, fungi, prions), recombinant DNA and/ or biological materials (cells, tissues, fluids) exposed to or likely to contain Risk Group 1 microbial agents or recombinant DNA (BSL-1)	• Sharps injuries • Eye irritation • Exposure of infectious material to those who may have personal health issues which make them more susceptible to infection; cross contamination of animal or extra laboratory areas	• Lab coat • Safety glasses • Disposable gloves Note: Additional PPE may be required based on risk assessment by the IBC	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	B3. Working with microbial agents, recombinant DNA and/or biological materials (cells, tissues, fluids) exposed to or likely to contain Risk Group 2 microbial agents or recombinant DNA (BSL-2)	• Sharps injuries • Exposure to infectious material, particularly through broken skin or mucous membranes	• Lab coat • Safety glasses • Double layer disposable gloves Note: Additional PPE may be required based on risk assessment by the IBC	All personnel in laboratory room: • Lab coat • Safety glasses

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	B4. Working with microbial agents, recombinant DNA and/or biological materials (cells, tissues, fluids) exposed to or likely to contain Risk Group 2 microbial agents or recombinant DNA for which Biosafety Level 3 practices are required (BSL-2+)	• Sharps injuries • Exposure to infectious material with high risk of exposure by contact skin or mucous membranes and other potential or unknown routes of entry and/or increased consequences of exposure	• Lab coat • Safety glasses • Barrier lab coat impervious to fluids • Double layer disposable gloves Note: Additional PPE may be required based on risk assessment by the IBC	All personnel in laboratory room: • Lab coat or disposable lab coat • Safety glasses
○ Yes ◉ No	B5. Working with microbial agents, recombinant DNA and/or biological materials (cells, tissues, fluids) exposed to or likely to contain Risk Group 3 microbial agents or recombinant DNA (BSL-3)	• Exposure to infectious materials with high risk of exposure, particularly through the inhalation route	• Respirator (for some work a higher level may be required N95 minimum) • Safety glasses • Solid-front protective laboratory coat or gown • Double layer disposable gloves • Shoe covers or dedicated shoes Note: Additional PPE may be required based on risk assessment by the IBC	All personnel in laboratory room: • Respirator (for some work a higher level may be required N95 minimum) • Safety glasses • Solid-front protective laboratory coat or gown • Double layer disposable gloves • Shoe covers or dedicated shoes

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	B6. Working with live animals only or in conjunction with Risk Group 1 microbial agents or recombinant DNA (ABSL-1)	• Sharps injuries • Eye irritation • Exposure of infectious material to those who may have personal health issues which make them more susceptible to infection; cross contamination of animal or extra laboratory areas • Animal bites • Allergies	• Lab coat • Safety glasses • Disposable gloves Note: Addtional PPE (e.g. puncture resistant gloves) may be required based on risk assessment by the IBC & IACUC. Additional gowning (shoe covers, face mask) may be required for animal welfare purposes.	All personnel in laboratory room: • Lab coat • Safety glasses
○ Yes ◉ No	B7. Working with infected or potentially infectious live animals alone or in conjunction with Risk Group 2 microbial agents or recombinant DNA (ABSL-2)	• Sharps injuries • Animal bites • Allergies • Exposure to infectious material	• Lab coat • Safety glasses • Bouffant cap • Disposable gloves Addtional PPE (e.g. puncture resistant gloves) may be required based on risk assessment by the IBC & IACUC. Additional gowning (shoe covers, face mask) may be required for animal welfare purposes.	All personnel in laboratory room: • Lab coat • Safety glasses • Bouffant cap

Radiological Hazards

Complete ✔

☐ I certify that all activities listed in the Radiological Hazards section below are NOT conducted in this laboratory.

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
◉ Yes ○ No	R1. Working with unsealed radioactive materials including generally licensed radioactive material or devices (e.g., uranyl acetate thorium nitrate, ^{32}P-labeled biomolecules)	• Cell damage • Potential spread of radioactive materials	• Lab coat • Safety glasses • Impermeable or chemical resistant gloves	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	R2. Working with unsealed radioactive materials in hazardous chemicals (corrosives, flammables, liquids, powders, etc.)	• Spread of contamination and hazards for the specific chemical • Cell damage	• Lab coat • Chemical-resistant gloves • Chemical splash goggles for larger volumes • Safety glasses Note: Select gloves for applicable chemical hazards above.	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	R3. Working with sealed radioactive sources or devices containing sources of radioactive materials (e.g., liquid scintillation counters, gas chromatographs/electron capture detectors, static eliminators, etc.)	• If sealed source is compromised due to removal from equipment or physical abuse: cell damage, potential spread of radioactive materials	• PPE is not necessary under normal operating instructions Note: Source may not be removed from device except by EH&S or manufacturer.	N/A

Laser Hazards

Complete ✔

☐ I certify that all activities listed in the Laser Hazards section below are NOT conducted in this laboratory.

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	L1. Open Beam - Performing alignment, trouble-shooting or maintenance that requires working with an open beam and/or defeating the interlocks on any Class 3 or Class 4 laser system	• Eye damage	• Optical density and wavelength-specific safety glasses based on individual beam parameters	All personnel in laser use room: • Optical density and wavelength-specific safety glasses based on individual beam parameters
○ Yes ◉ No	L2. Open Beam - Viewing a Class 3R laser beam with magnifying optics	• Eye damage	• Optical density and wavelength-specific safety glasses based on individual beam parameters	N/A
○ Yes ◉ No	L3. Open Beam - Working with a Class 3B laser open beam system with the potential for producing direct or specular reflections	• Eye damage	• Lab coat or appropriate clothes • Optical density and wavelength-specific safety glasses based on individual beam parameters	All personnel in laser use room: • Lab coat or appropriate clothes • Optical density and wavelength-specific safety glasses based on individual beam parameters
○ Yes ◉ No	L4. Open Beam - Working with a Class 4 laser open beam system with the potential for producing direct, specular or diffuse reflections	• Eye or skin damage	• Lab coat or appropriate clothes • Optical density and wavelength-specific safety glasses based on individual beam parameters	All personnel in laser use room: • Lab coat or appropriate clothes • Optical density and wavelength-specific safety glasses based on individual beam parameters

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	L5. Non-Beam - Handling dye laser materials such as dyes, chemicals, and solvents	• Cancer • Explosion • Fire	• Chemical-resistant gloves • Flame resistant lab coat (NFPA 2112) • Safety glasses	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	L6. Non-Beam - Maintaining and repairing power sources for large Class 3B and Class 4 lasers	• Explosion • Fire • Electrocution	• Electrical protection lab coat (NFPA 70E) or coveralls • Electrical isolation mat	N/A
◉ Yes ○ No	L7. Enclosed Beam - Using a Class 1 device housing a Class 3B or Class 4 enclosed or embedded laser with the potential for beam exposure during a servicing event	• Eye or skin damage	• Lab coat or appropriate clothes • Optical density and wavelength-specific safety glasses based on individual beam parameters	All personnel in laser use room: • Lab coat or appropriate clothes • Optical density and wavelength-specific safety glasses based on individual beam parameters

Non-Ionizing Radiation Hazards

Complete ✔

☑ I certify that all activities listed in the Non-Ionizing Hazard Radiation Hazards section below are NOT conducted in this laboratory.

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	N1. Working with unshielded sources of ultraviolet radiation	• Conjunctivitis, corneal damage, skin redness	• Lab coat • UV face-shield • Gloves	In adjacent area with direct line of sight: • Lab coat • UV face-shield

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	N2. Working with intense infrared emitting equipment (e.g. glass blowing)	• Cataracts, burns to cornea	• Lab coat • Appropriate shaded glasses	In adjacent area with direct line of sight: • Lab coat • Appropriate shaded glasses

Custom Laboratory Activities - Optional

No Custom Laboratory Activities have been identified.

Cell Lab Assessment

Certified Laboratory Hazard Assessment (certified on 10/13/2016)

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.

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

Building	Room
Materials Research Lab	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.

Recommended PPE

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

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.
- Work with liquid pyrophoric chemicals outside of an inert atmosphere glove box requires flame resistant inner gloves and chemical resistant outer gloves.
- Flame resistant inner gloves are recommended when quenching water reactive chemicals that release flammable gases.

All Laboratories — Complete ✔

Response	Lab Activity
○ Yes ◉ No	This laboratory has been designated and posted as free of chemical, physical, biological, radiological, laser, and non-ionizing hazards. Skip all other sections.

Chemical Hazards — Complete ✔

☑ I certify that all activities listed in the Chemical Hazards section below are NOT conducted in this laboratory.

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	C1. Working with hazardous chemicals (solid, liquid, or gas)	• Eye or skin damage • Potential poisoning through skin contact	• Lab coat • Chemical-resistant gloves • Chemical splash goggles for larger volumes • Safety glasses	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	C2. Working with hazardous liquids or other materials which create a splash hazard	• Eye or skin damage • Poisoning	• Lab coat • Chemical splash goggles • Chemical-resistant gloves • Chemical-resistant apron should be considered • Face shield should be considered	In adjacent area: • Lab coat • Safety glasses

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	C3. Working with small volumes (<= 4L) of corrosive liquids or solids	• Eye or skin damage • Low probability for a splash hazard	• Lab coat • Chemical-resistant gloves • Safety glasses	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	C4. Working with large volumes (> 4L) of corrosive liquids or solids	• Eye or skin damage • Low probability for a splash hazard	• Lab coat • Chemical splash goggles • Chemical-resistant gloves • Chemical-resistant apron	In adjacent area: • Lab coat • Chemical splash goggles
○ Yes ◉ No	C5. Working with small volumes (<= 1L) of flammable solvents/materials when no reasonable ignition sources are present	• Eye or skin damage • Potential poisoning through skin contact	• Lab coat • Chemical-resistant gloves • Safety glasses	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	C6. Working with large volumes (> 1L) of flammable solvents/materials	• Potential poisoning through skin contact • Major fire • Major skin or eye damage	• Chemical-resistant gloves • Flame resistant lab coat (NFPA 2112) • Safety glasses • Flame-resistant outer gloves should be considered	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	C7. Working with any quantity of flammable solvents/materials when there are reasonable ignition sources present; or working in areas where flammable concentrations of vapors or gas may be present	• Potential poisoning through skin contact • Major fire • Major skin or eye damage	• Chemical-resistant gloves • Flame resistant lab coat (NFPA 2112) • Safety glasses • Flame-resistant outer gloves highly recommended	All personnel in laboratory room; • Flame resistant lab coat (NFPA 2112) • Safety glasses
○ Yes ◉ No	C8. Working with Category 1 or 2 acutely toxic chemicals	• Spills, splashes, ingestion, inhalation, absorption • Chemicals pose a high level of immediate health risk	• Lab coat • Chemical-resistant gloves • Safety glasses • Chemical protective apron for H310	In adjacent area: • Lab coat • Safety glasses

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	C9. Working with known or suspect human carcinogens	• High hazard cancer-causing agents • Spills, splashes, ingestion, inhalation, absorption	• Lab coat • Chemical-resistant gloves • Safety glasses	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	C10. Working with reproductive hazard chemicals (including reproductive toxicants and germ cell mutagens)	• Agents that affect reproductive capabilities, cause mutation and adversely affect fetal development • Spills, splashes, ingestion, inhalation, absorption	• Lab coat • Chemical-resistant gloves • Safety glasses	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	C11. Working with pyrophoric (air reactive) chemicals or chemicals that in contact with water release flammable gasses (water reactive)	• Severe skin and eye damage • Fire	• Chemical-resistant gloves • Flame resistant lab coat (NFPA 2112) • Flame resistant inner gloves required in some circumstances • Safety glasses • Face shield should be considered Note: Work in inert atmosphere when possible	All personnel in laboratory room; • Flame resistant lab coat (NFPA 2112) • Safety glasses
○ Yes ◉ No	C11A. Working with pyrophoric chemicals (or reagents)	• Severe skin and eye damage • Fire	• Flame resistant lab coat (NFPA 2112) • Safety glasses • Face shield should be considered • Chemical-resistant outer gloves • Flame resistant inner gloves or glove liners	All personnel in laboratory room; • Flame resistant lab coat (NFPA 2112) • Safety glasses

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	C11B. (New Question) Working with substances which in contact with water emit flammable gases	• Severe skin and eye damage • Fire	• Chemical-resistant gloves • Flame resistant lab coat (NFPA 2112) • Safety glasses • Face shield should be considered • Flame resistant inner gloves or glove liners	All personnel in laboratory room; • Flame resistant lab coat (NFPA 2112) • Safety glasses
○ Yes ◉ No	C12. Working with potentially explosive chemicals	• Splash, detonation, flying debris • Eye or skin damage • Fire	• Chemical-resistant gloves • Flame resistant lab coat (NFPA 2112) • Blast shield should be considered • Safety glasses • Face shield should be considered	All personnel in laboratory room; • Chemical splash goggles • Flame resistant lab coat (NFPA 2112) • Safety glasses
○ Yes ◉ No	C13. Working with Category 2 or higher engineered nanomaterials	• Inhalation, exposure, dermal exposure	• Lab coat • Chemical-resistant gloves • Safety glasses	All personnel in laboratory room; • Lab coat • Safety glasses
○ Yes ◉ No	C14. Minor chemical spill cleanup	• Respiratory damage • Eye or skin damage	• Lab coat • Chemical-resistant gloves • Chemical-resistant apron • Safety glasses • Shoe covers	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	C15. Major chemical spill cleanup	• Multiple hazards	• Call EH&S for assistance	All personnel in laboratory room must evacuate lab

Physical Hazards

Complete ✔

☐ I certify that all activities listed in the Physical Hazards section below are NOT conducted in this laboratory.

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	P1. Working with cryogenic liquids	• Major skin, tissue, or eye damage	• Lab coat • Chemical splash goggles for larger volumes • Safety glasses • Face shield should be considered • Cryogenic protective gloves	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	P2. Working with very cold equipment, samples, or dry ice	• Frostbite, hypothermia	• Lab coat • Safety glasses • Cryogenic protective gloves • Possibly warm clothing	N/A
◉ Yes ○ No	P3. Removing sealed vials from liquid nitrogen	• Vials may explode upon rapid warming • Cuts to face/neck and frostbite to hands	• Lab coat • Safety glasses • Face shield should be considered • Cryogenic protective gloves	In adjacent area: • Lab coat • Safety glasses
◉ Yes ○ No	P4. Working with scalding liquids or hot equipment (e.g., autoclave, water bath, oil bath)	• Eye or skin damage • Burns	• Lab coat • Chemical splash goggles for larger volumes • Safety glasses • Thermal protective gloves (impermeable insulated gloves for liquids and steam)	N/A
○ Yes ◉ No	P5. Glassware washing	• Lacerations, chemical splash	• Lab coat • Chemical-resistant gloves • Safety glasses	N/A
○ Yes ◉ No	P6. Working with loud equipment, noises, sounds, alarms, etc.	• Potential ear damage and hearing loss	• Hearing protection (consult EH&S for SNR factor needed)	In adjacent area: • Hearing protection (consult EH&S for SNR factor needed)

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	P7. Working with a high-powered sonicator	• Ear damage, tissue damage	• Lab coat • Safety glasses • Hearing protection (consult EH&S for SNR factor needed) • Disposable gloves	In adjacent area: • Hearing protection (consult EH&S for SNR factor needed)
◉ Yes ○ No	P8. Working with a centrifuge	• Imbalanced rotor can lead to broken vials, cuts, exposure, projectiles	• Lab coat • Safety glasses • Disposable gloves	N/A
◉ Yes ○ No	P9. Working with sharps (e.g. needles, razor blades and broken glass)	• Exposure • Cuts	• Lab coat • Cut resistant gloves should be considered • Safety glasses	N/A
○ Yes ◉ No	P10. Working with an apparatus containing materials under pressure or vacuum	• Eye or skin damage • Projectiles	• Lab coat • Chemical-resistant gloves • Chemical-resistant apron (for high risk activities) • Safety glasses • Face shield should be considered (for high risk activities)	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	P11. Working with a microtome	• Cuts, pinch and exposure	• Lab coat • Cut-resistant gloves • Safety glasses	N/A

Biological Hazards

Complete ✔

☐ I certify that all activities listed in the Biological Hazards section below are NOT conducted in this laboratory.

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
(•) Yes ( ) No	B1. Working with human or non-human primate blood, body fluids, tissues, cells or other potentially infectious material (OPIM) which may contain human bloodborne pathogens (BBP)	• Sharps injuries • Exposure to infectious material	• Barrier lab coat impervious to fluids • Disposable gloves • Eye and mucous membrane protection (as appropriate for operations)	In adjacent area: • Lab coat • Safety glasses
(•) Yes ( ) No	B2. Working with microbial agents (bacteria, virus, parasites, yeast, fungi, prions), recombinant DNA and/ or biological materials (cells, tissues, fluids) exposed to or likely to contain Risk Group 1 microbial agents or recombinant DNA (BSL-1)	• Sharps injuries • Eye irritation • Exposure of infectious material to those who may have personal health issues which make them more susceptible to infection; cross contamination of animal or extra laboratory areas	• Lab coat • Safety glasses • Disposable gloves Note: Additional PPE may be required based on risk assessment by the IBC	In adjacent area: • Lab coat • Safety glasses
(•) Yes ( ) No	B3. Working with microbial agents, recombinant DNA and/or biological materials (cells, tissues, fluids) exposed to or likely to contain Risk Group 2 microbial agents or recombinant DNA (BSL-2)	• Sharps injuries • Exposure to infectious material, particularly through broken skin or mucous membranes	• Lab coat • Safety glasses • Double layer disposable gloves Note: Additional PPE may be required based on risk assessment by the IBC	All personnel in laboratory room: • Lab coat • Safety glasses

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	B4. Working with microbial agents, recombinant DNA and/or biological materials (cells, tissues, fluids) exposed to or likely to contain Risk Group 2 microbial agents or recombinant DNA for which Biosafety Level 3 practices are required (BSL-2+)	• Sharps injuries • Exposure to infectious material with high risk of exposure by contact skin or mucous membranes and other potential or unknown routes of entry and/or increased consequences of exposure	• Lab coat • Safety glasses • Barrier lab coat impervious to fluids • Double layer disposable gloves Note: Additional PPE may be required based on risk assessment by the IBC	All personnel in laboratory room: • Lab coat or disposable lab coat • Safety glasses
○ Yes ◉ No	B5. Working with microbial agents, recombinant DNA and/or biological materials (cells, tissues, fluids) exposed to or likely to contain Risk Group 3 microbial agents or recombinant DNA (BSL-3)	• Exposure to infectious materials with high risk of exposure, particularly through the inhalation route	• Respirator (for some work a higher level may be required N95 minimum) • Safety glasses • Solid-front protective laboratory coat or gown • Double layer disposable gloves • Shoe covers or dedicated shoes Note: Additional PPE may be required based on risk assessment by the IBC	All personnel in laboratory room: • Respirator (for some work a higher level may be required N95 minimum) • Safety glasses • Solid-front protective laboratory coat or gown • Double layer disposable gloves • Shoe covers or dedicated shoes

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	B6. Working with live animals only or in conjunction with Risk Group 1 microbial agents or recombinant DNA (ABSL-1)	• Sharps injuries • Eye irritation • Exposure of infectious material to those who may have personal health issues which make them more susceptible to infection; cross contamination of animal or extra laboratory areas • Animal bites • Allergies	• Lab coat • Safety glasses • Disposable gloves Note: Addtional PPE (e.g. puncture resistant gloves) may be required based on risk assessment by the IBC & IACUC. Additional gowning (shoe covers, face mask) may be required for animal welfare purposes.	All personnel in laboratory room: • Lab coat • Safety glasses
○ Yes ◉ No	B7. Working with infected or potentially infectious live animals alone or in conjunction with Risk Group 2 microbial agents or recombinant DNA (ABSL-2)	• Sharps injuries • Animal bites • Allergies • Exposure to infectious material	• Lab coat • Safety glasses • Bouffant cap • Disposable gloves Addtional PPE (e.g. puncture resistant gloves) may be required based on risk assessment by the IBC & IACUC. Additional gowning (shoe covers, face mask) may be required for animal welfare purposes.	All personnel in laboratory room: • Lab coat • Safety glasses • Bouffant cap

Radiological Hazards

Complete ✔

☑ I certify that all activities listed in the Radiological Hazards section below are NOT conducted in this laboratory.

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	R1. Working with unsealed radioactive materials including generally licensed radioactive material or devices (e.g., uranyl acetate thorium nitrate, ^{32}P-labeled biomolecules)	• Cell damage • Potential spread of radioactive materials	• Lab coat • Safety glasses • Impermeable or chemical resistant gloves	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	R2. Working with unsealed radioactive materials in hazardous chemicals (corrosives, flammables, liquids, powders, etc.)	• Spread of contamination and hazards for the specific chemical • Cell damage	• Lab coat • Chemical-resistant gloves • Chemical splash goggles for larger volumes • Safety glasses Note: Select gloves for applicable chemical hazards above.	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	R3. Working with sealed radioactive sources or devices containing sources of radioactive materials (e.g., liquid scintillation counters, gas chromatographs/electron capture detectors, static eliminators, etc.)	• If sealed source is compromised due to removal from equipment or physical abuse: cell damage, potential spread of radioactive materials	• PPE is not necessary under normal operating instructions Note: Source may not be removed from device except by EH&S or manufacturer.	N/A

Laser Hazards

Complete ✔

☑ I certify that all activities listed in the Laser Hazards section below are NOT conducted in this laboratory.

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	L5. Non-Beam - Handling dye laser materials such as dyes, chemicals, and solvents	• Cancer • Explosion • Fire	• Chemical-resistant gloves • Flame resistant lab coat (NFPA 2112) • Safety glasses	In adjacent area: • Lab coat • Safety glasses
○ Yes ◉ No	L6. Non-Beam - Maintaining and repairing power sources for large Class 3B and Class 4 lasers	• Explosion • Fire • Electrocution	• Electrical protection lab coat (NFPA 70E) or coveralls • Electrical isolation mat	N/A
○ Yes ◉ No	L7. Enclosed Beam - Using a Class 1 device housing a Class 3B or Class 4 enclosed or embedded laser with the potential for beam exposure during a servicing event	• Eye or skin damage	• Lab coat or appropriate clothes • Optical density and wavelength-specific safety glasses based on individual beam parameters	All personnel in laser use room: • Lab coat or appropriate clothes • Optical density and wavelength-specific safety glasses based on individual beam parameters

Non-Ionizing Radiation Hazards

Complete ✔

☑ I certify that all activities listed in the Non-Ionizing Hazard Radiation Hazards section below are NOT conducted in this laboratory.

Response	Lab Activity	Potential Hazards	Active Researchers PPE	Adjacent Individuals PPE
○ Yes ◉ No	N1. Working with unshielded sources of ultraviolet radiation	• Conjunctivitis, corneal damage, skin redness	• Lab coat • UV face-shield • Gloves	In adjacent area with direct line of sight: • Lab coat • UV face-shield

LOM Assessment

Certified Laboratory Hazard Assessment (certified on 11/27/2017)

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.

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

Building	Room
Materials Research Lab	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.

Recommended PPE

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

All Laboratories — Complete ✔

Response	Lab Activity
◉ Yes ○ No	This laboratory has been designated and posted as free of chemical, physical, biological, radiological, laser, and non-ionizing hazards. Skip all other sections.

Chemical Hazards — Complete ✔

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UCSB Laboratory Safety Manual and Chemical Hygiene Plan

Prepared by UCSB Environmental Health & Safety

SECTION II (2):

UCSB POLICIES, PROCEDURES AND RESOURCES

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://www.ehs.ucsb.edu/labsafety-chp/sec2*

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 January 2018 (which is the current version on the EH&S website as of February 22, 2018) 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/labsafety-chp

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SECTION II:
UC/UCSB POLICIES, PROCEDURES AND RESOURCES

Introduction to Section II: UCSB/UC 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 Chemical Hygiene Plans (CHP), they are provided herein. In Section 1 *laboratory-specific* issues/SOPs are addressed.

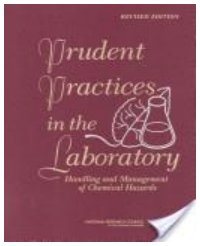
The information here is a formal part of the *UCSB Chemical Hygiene Plan*. Therefore, all lab personnel are responsible for being familiar with this information and following the prescriptions therein as they apply to their work. Almost all of the issues addressed herein are based on current regulations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

Addressing Non-Chemical Hazards

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

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

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



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

Minors in Laboratories and Shops:

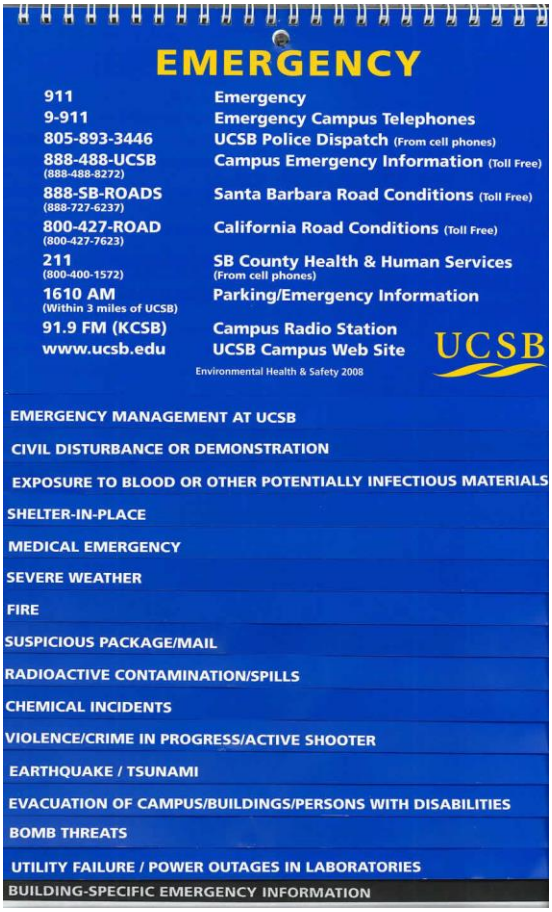
A UC policy describes the limitations on minors working in these campus areas. A summary of the policy can be found here. The lab supervisor/PI has the primary responsibility for following this policy in their areas.

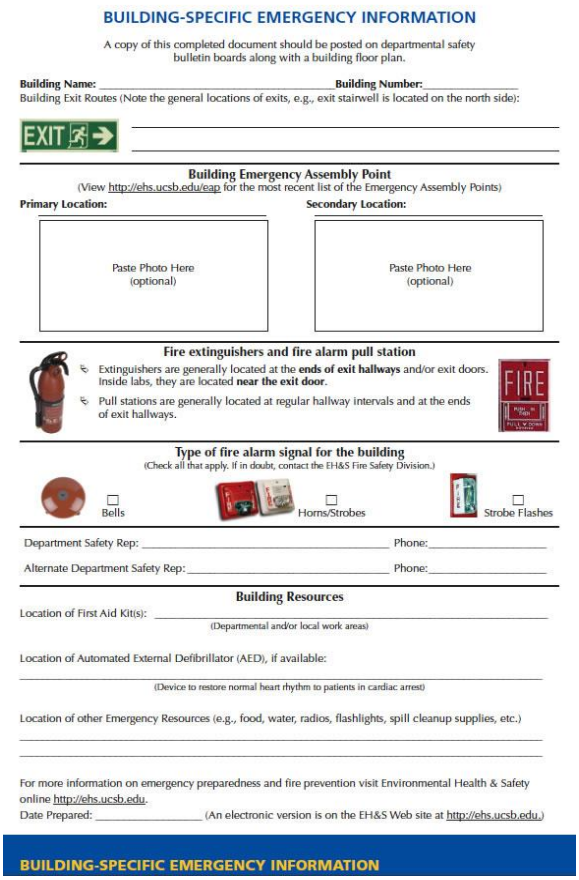
Emergency Response Procedures

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. A Spanish version of the flipchart is available.

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

Power outages in labs are of particular concern – preparing for them and what to do during and afterwards. A fact sheet with some basic guidelines can be found here





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 **911** (campus phone)

Spill Response Scheme:

Evaluate and Notify

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

Containment/Cleanup

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

Followup

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

**Self-help spill cleanup equipment are available using graduate keys in some buildings.*

Fire Extinguishers, First-Aid Kits and Emergency Showers/Eyewashes

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

Online Fire Extinguisher Usage Refresher Training:

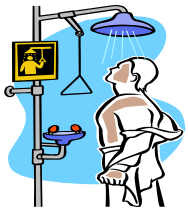
UC Learning Center

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

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

Emergency Showers and Eyewashes

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



UC Policy on Laboratory Personal Protective Equipment (PPE)

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

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

Other Policy Aspects:

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

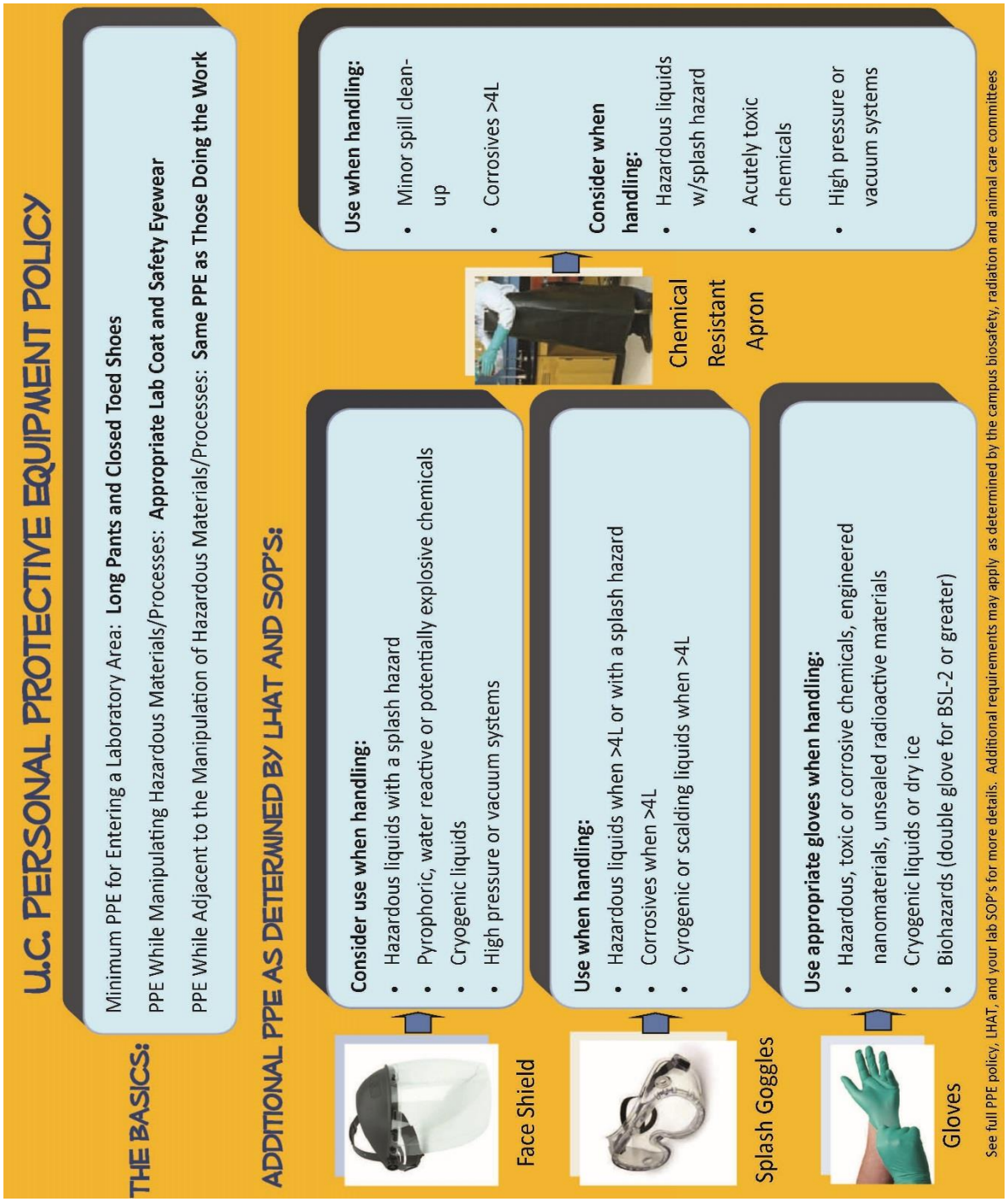
- Supervisors shall perform a **written assessment** of workplace to determine what PPE is needed – OSHA requirement. This is done via use the online *UC Laboratory Hazard Assessment Tool* ("LHAT"). The assessment should be updated and re-certified by at least every 3 years, or more often if needed.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

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

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

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

- **Teaching courses** which include lab/shop/field work are required to indicate PPE requirements in the course syllabus or manual**. The PPE requirements for teaching labs are the same as for research labs**. The instructor of record for the course, or designee, is responsible for determining the appropriate PPE and ensuring that students are familiar with and properly use PPE. However, since teaching labs do not go through the LHAT process above, the instructor is responsible for determining which type of safety eyewear are necessary – click here for guidance.



Posted at main doorway to each campus lab

Obtaining Free Laboratory Personal Protective Equipment (PPE) Via the UC Laboratory Hazard Assessment Tool ("LHAT")

To facilitate the policy summarized on pg. II-6, UC provides the following resources:

1. The online ***Laboratory Hazard Assessment Tool*** ("LHAT") https://ehs.ucop.edu/lhat/ is for supervisor's to do PPE assessments for their workers. The LHAT can only be accessed via an individual's UCSB NetID and password. Per UC policy, the LHAT assessment must be re-certified/revised online at least every 3 years, or more often if changes occur. Contact EH&S for assistance.
2. For lab workers, the LHAT provides a summary of the lab's PPE needs and provides/documents training on basic lab coat and eyewear use and maintenance
3. Free laboratory coats (3 types for different hazards), safety eyewear and communal face shields and lab aprons – see below. Use & Limitations of UC-provided PPE.
4. Free lab coat laundering services – see below

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

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

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

Respiratory Protection

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

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

If you believe respiratory protection equipment may be necessary, of if an individual would like to wear equipment voluntarily, please contact the *UCSB Respiratory Protection Program* (x-3743, x-8787, or rpp@ucsb.edu) for review and approval. There is a wide variety of respiratory protection equipment available, and each has specific applications, limitations and use requirements. It is extremely important that equipment is selected and used properly, to ensure that the respirator itself does not create an additional hazard.

Selecting the Proper Gloves

The correct gloves protect against chemicals; the wrong gloves enhance chemical contact. **There is no universal glove that protects you from all chemicals. To choose the correct glove, go to a Glove Reference Chart -** links below. Chlorinated solvents are carcinogenic and are particularly challenging to find appropriate gloves for.

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

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

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

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

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

Microflex Chemical Resistance Guide

Cole-Parmer

Ansell Chemical Resistance Guide

UC Policy on Laboratory Safety Training

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

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

Accessing the *Fundamentals of Laboratory Safety* Orientations (mandatory per UC policy)

- **Live Version:** 3-hour, instructor-led training is offered regularly - generally once per quarter. Enroll via the UC Learning Center using UCSB NetID*. Search on "LS01". This training is **more in-depth** than the online version below and generally **includes hands-on fire extinguisher training.**

- **Online Version:** Available via the UC Learning Center using UCSB NetID*. Search on "LS60"

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

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

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

Exposure Limits for Laboratory Chemicals & Carcinogens

Under OSHA, there are 500+ chemicals that have airborne chemical concentration limits known as *Permissible Exposure Limits (PEL).* **Legally, you cannot be exposed above these limits**. PELs are expressed in parts per million (or mg/m^3) in air. PEL values can be for 15 minute or 8 hour exposure periods, or ceiling limits which should never be exceeded. A smaller table of **PEL values** for ~50 common lab chemicals is available.

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

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

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

Select Carcinogens are defined under the OSHA Lab Safety Standard as follows.

- Regulated Carcinogens (see above)
- *Annual Report on Carcinogens* published by the *National Toxicology Program*: all of the substances listed as "known to be carcinogens" and some listed as "reasonably anticipated to be carcinogens"
- *International Agency for Research on Cancer*: all of Group 1 "carcinogen to humans" materials; and some in Group 2A/B.

Safety Data Sheets (SDS, formerly known as MSDS)

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

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

(M)SDS Sources:

Google Customized SDS Search

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

Fisher Scientific

SIRI

Sigma-Aldrich SDS

Matheson's Gases

Chemical Labelling

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

General requirements

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

For commercial materials in the original vendor's container

- Manufacturer's product labels must remain on all containers, and not be defaced

For materials repackaged in the laboratory

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

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

Pictograms and Hazard Codes Used in the Globally Harmonized Chemical Labeling System

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.

Description	Pictogram	Hazard class and hazard category:
Exploding Bomb GHS01		Unstable explosives Explosives of Divisions 1.1, 1.2, 1.3, 1.4 Self reactive substances and mixtures, Types A,B Organic peroxides, Types A,B
Flame GHS02		Flammable gases, category 1 Flammable aerosols, categories 1,2 Flammable liquids, categories 1,2,3 Flammable solids, categories 1,2 Self-reactive substances and mixtures, Types B,C,D,E,F Pyrophoric liquids, and solids, category 1 Self-heating substances and mixtures, categories 1,2 Substances and mixtures, which in contact with water, emit flammable gases, categories 1,2,3 Organic peroxides, Types B,C,D,E,F
Flame Over Circle GHS03		Oxidizing gases, category 1 Oxidizing liquids, categories 1,2,3
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 and 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, category1 - Chronic hazard, categories 1,2

Criteria for Implementing Engineering Controls

The next few pages deal primarily with "engineering controls", i.e. fume hoods, gas cabinets, glove boxes, etc. **Engineering controls are considered the "first line of defense" in protecting workers. In contrast, PPE is generally considered the final defense.** The Lab Standard requires that the general criteria for implementing control measures be described. The appropriate engineering control is often obvious, but the general criteria are noted here for the common ones. The criteria should be followed unless equivalent protection can be realized. Specific engineering controls should also be described in a lab's SOPs.

FUME HOODS, WET BENCHES, GAS CABINETS & OTHER EXHAUST VENTILATION

- When using volatile substances that present a significant inhalation hazard
- When necessary to keep exposure levels below OSHA Permissible Exposure Limits
- When using toxic gases, particularly when required by the CA Fire Code
- When indicated in Standard Operating Procedures, or as indicated in SDS

BIOSAFETY CABINETS

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

GLOVE BOXES

- When indicated in Standard Operating Procedures

APPROVED HAZARDOUS MATERIALS STORAGE CABINETS AND SAFETY CANS

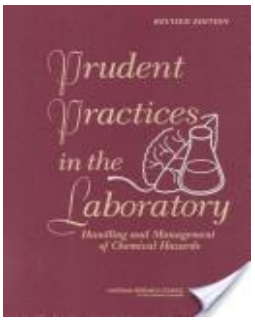
- Whenever possible, but particularly when CA fire code volume limits are exceeded
- When indicated in Standard Operating Procedures

FLAMMABLE STORAGE REFRIGERATORS (APPROVED-TYPE)

- When refrigerated storage of flammable materials is needed

General Procedures for Working with Hazardous Chemicals and Operations

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



4 Evaluating Hazards and Assessing Risks in the Laboratory

4.A Introduction
4.B Sources of Information
4.C Toxic Effects of Laboratory Chemicals
4.D Flammable, Reactive, and Explosive Hazards
4.E Physical Hazards
- Compressed Gases
- Nonflammable Cryogens
- High-Pressure Reactions
- Vacuum Work
- Ultraviolet, Visible, and Near-Infrared Radiation
- Radio Frequency and Microwave Hazards
- Electrical Hazards
- Magnetic Fields
- Sharp Edges
- Slips, Trips, and Falls
- Ergonomic Hazards in the Laboratory

4.F Nanomaterials
4.G Biohazards (see also, *UCSB Biosafety Program*)
4.H Hazards from Radioactivity (see also, *UCSB Radiation Safety Program*)

5 Management of Chemicals

6 Working with Chemicals

7 Working with Laboratory Equipment

Fume Hood Usage Guide: Standard Hoods

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

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

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

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

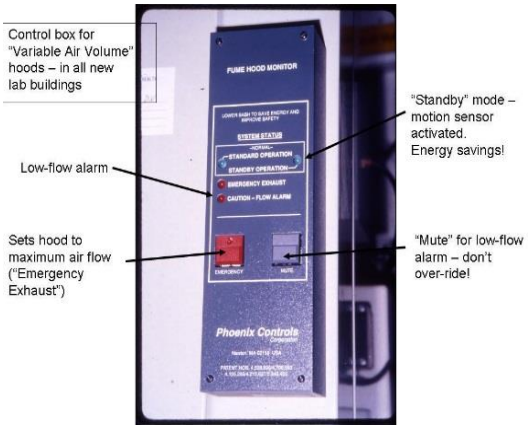
**"Magnihelic gauge" – note normal gauge position. Significant deviation may indicate low air flow.*

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

Fume Hood Usage Guide: Variable Air Volume Hoods ("Phoenix" system)

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

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



Refrigerators and Freezers in Labs

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

FLAMMABLE MATERIAL STORAGE REFRIGERATORS/FREEZERS:

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

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

Examples of signage on campus lab refrigerators

UCI refrigerator which exploded when chemicals were stored in a unit which was not designed for flammables

EH&S Laboratory Inspection and Lab Outreach Programs

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

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

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

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

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 waste containers. Available for free – see below.

SEGREGATION: group waste into the following categories:

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

DISPOSAL

- <u>Chemicals may not be disposed in regular trash, sink disposed, or allowed to evaporate.</u>
- Complete a *UCSB Waste Pick-up Request Form*. Send by campus mail or fax(X8659). Also available on the *EH&S website* for electronic submission
- EH&S cannot accept responsibility for improperly labeled, packaged, and/or segregated chemicals, and will not pick them up.
- Waste containers become the property of EH&S and will not be returned

UCSB Hazardous Waste Label

Laboratory Sharps Disposal

"Sharps waste" means any device having acute rigid corners, edges, or protuberances capable of cutting or piercing, including, but not limited to, all of the following: hypodermic needles, syringes, razor blades and scalpel blades. Glass items contaminated with biohazards, such as pipettes, microscope slides and capillary tubes are also a "sharps waste." **Under no circumstances should "sharps waste" be disposed of in the normal trash. Sharps must be disposed of through EH&S, or a medical waste management company.**

Sharps Contaminated with Hazardous Chemical Waste

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

Sharps Contaminated with Radioactive Materials

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

Sharps Contaminated with Medical or Biohazardous Waste

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

Unused or Non-Contaminated Hypodermic Needles

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

Laboratory Glass Disposal

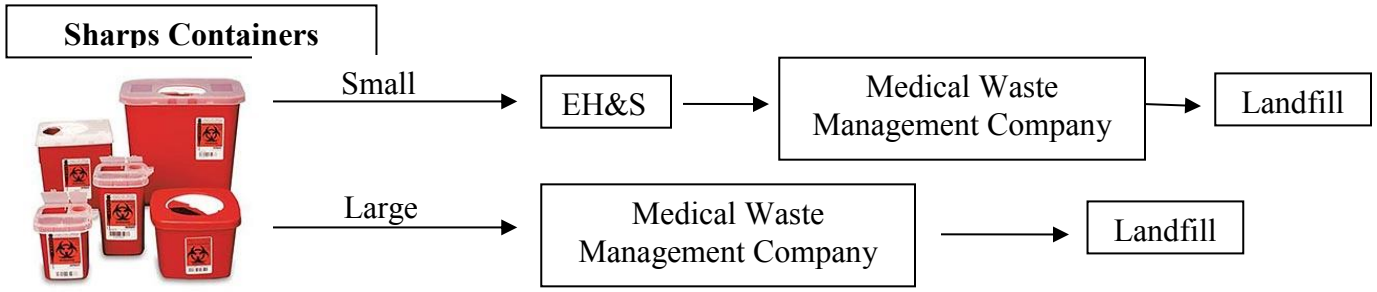
Definition: Laboratory glass is defined as equipment generally made of pyrex, borosilicate, and quartz glass used for scientific experiments. Examples of laboratory glass include, but are not limited to, the following: beakers, flasks, graduated cylinders, stirring rods, test tubes, microscope slides, glass pipettes, glass petri dishes, and glass vials. **Glass items contaminated with biohazards, such as pipettes,**

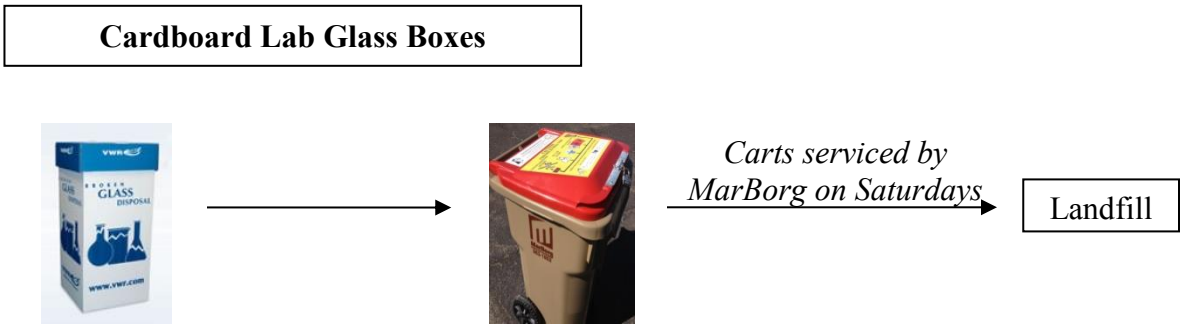
microscope slides, and capillary tubes are considered "sharps waste". Under no circumstances should "sharps waste" be disposed of in the normal trash. Sharps must be disposed through EH&S or a certified medical waste management company.

Directions:

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

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





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UCSB Laboratory Safety Manual and Chemical Hygiene Plan

Prepared by UCSB Environmental Health & Safety

SECTION III (3):

REGULATORY FRAMEWORK

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/labsafety-chp/sec3

*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 January 2018 (which is the current version on the EH&S website as of February 22, 2018) 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/labsafety-chp

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Section III: REGULATORY FRAMEWORK

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

A. THE CAL-OSHA LABORATORY SAFETY STANDARD

1. *Background*

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

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

2. *Applicability*

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

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

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

3. *Summary of the Laboratory Safety Standard*

The Laboratory Standard contains the following elements.

- **Chemical Hygiene Plan (CHP)—** A written plan (this document) must be developed to control and minimize chemical exposure in laboratories. The CHP must be readily available to affected employees, who need to be oriented to its provisions and relevance to their health and safety. A CHP is required where hazardous chemicals, as defined by OSHA, are used in the workplace. The CHP must be:

  (A) Capable of protecting employees from health hazards associated with hazardous chemicals
  (B) Capable of keeping exposures below OSHA Permissible Exposure Limits

- **Responsibilities—** Personnel responsible for implementation of the CHP must be designated, including the appointment of a Chemical Hygiene Officer. *[Sec. III.B]*

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

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

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

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

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

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

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

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

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

B. RESPONSIBILITIES

a. Management

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

b. Laboratory Supervisors/Principal Investigators

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

c. Environmental Health & Safety (EH&S)

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

d. Chemical Hygiene Officer

The Lab Standard specifically calls for the appointment of a *Chemical Hygiene Officer*: "***An employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan."*** This CHO role at UCSB is now assigned as follows:

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

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

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

e. Laboratory Safety Committee

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

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

f. Departments and Organized Research Units

- Under the campus *Injury and Illness Prevention Program* (Cal-OSHA requirement), and the associated UCSB written program, the **department/unit Head or Chair is identified as the individual with the authority and responsibility to implement the IIPP.** The IIPP is the umbrella OSHA regulation, under which all worker safety programs exist.

- To assist the Chair/Unit Head, each department has a *Department Safety Representative (DSR)* who coordinates health and safety program elements in the department and serves as a liaison with EH&S.

- General oversight of department operations and communicating with supervisors and personnel any relevant safety issues, problem solving, and preplanning for emergencies.

- Per UC policy, depts. are responsible for ensuring that all new lab workers attend a *Fundamentals of Laboratory Safety* orientation before lab access is granted - Sec. III.C.1.

- Ensure that all operations under departmental control develop and implement lab-specific CHPs. While individual lab supervisors have the primary responsibility, department administrations need to coordinate and support these efforts.

g. Laboratory Workers (non-supervisors)

General responsibilities are below - a more complete list is online.

- Follow established work policies and procedures, including the UC Personal Protective Equipment policy; Laboratory Safety Training policy, CHP and authorizations from campus safety committees.
- Attend and actively participate in appropriate safety training.
- Notify the laboratory supervisor or EH&S of any unsafe or potentially unsafe condition.

Workers have rights under the law - See also the *UCSB Injury & Illness Prevention Program*

- to be informed of the hazards in their workplace
- to be properly trained on safe work practices
- to be provided appropriate personal protective equipment needed for the job at no cost
- to file a complaint with Cal-OSHA if they feel they are being exposed to unsafe conditions and no reprisals can be taken against them.

h. Facilities Management - see Section III.C.5

C. PROGRAM ELEMENTS OF THE UCSB CHEMICAL HYGIENE PLAN

1. Employee Information and Training

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

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

UC Laboratory Safety Training Policy

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

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

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

Safety Training Required by the Laboratory Safety Standard

(* = topic covered/documented in the EH&S *Fundamentals of Laboratory Safety* class per UC policy)

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

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

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

-Appropriate use of control measures including engineering controls, personal protective equipment, and work practices. ***[Generic control measures covered by EH&S*]***

2. Standard Operating Procedures

The OSHA Laboratory Safety Standard states that a laboratory's CHP include: ***"Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals",*** defined as:

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

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

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

3. Particularly Hazardous Substances (PHS)

The Laboratory Standard states that: ***"The Chemical Hygiene Plan shall include... provisions for additional employee protection for work with hazardous substances, including "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity***

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

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

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

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

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

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

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

4. Criteria for Determination and Implementation of Control Measures

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

A. General

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

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

C. Administrative Controls—Criteria for Implementation

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

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

D. Personal Protective Equipment—Criteria for Implementation

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

5. Maintenance of Engineering Controls, Personal Protective Equipment and Emergency Equipment

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

General Responsibilities:

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

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

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

Specific Responsibilities:

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

Maintenance:	Facilities Management
Annual certification:	EH&S

BIOSAFETY CABINETS (per CCR, Title 8, 5154.2)

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

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

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

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

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. Supervisors are responsible for identifying and directing individuals to EH&S who may require respirators.

Maintenance: Lab supervisor or designee

OTHER PERSONAL PROTECTIVE EQUIPMENT (per CCR, Title 8, 3380-3387)

Maintenance: Generally provided by UCSB, or the lab supervisor – maintenance & replacement are the responsibility of the supervisor and lab personnel. See Sec. II-6 to -10.

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, or 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 hazmat response equipment stores for the campus. Individual labs or departments may have local supplies.

6. Hazard Identification

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

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

7. Prior Approval

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

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

8. Medical Consultation and Examination

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

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

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

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

9. Criteria for Establishing Exposure Monitoring

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

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

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