UC SANTA BARBARA

CHEMICAL HYGIENE PLAN

and Laboratory Safety Manual

A Written Safety Program for Laboratories Utilizing Hazardous Chemicals

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Laboratory Safety Manual and Chemical Hygiene Plan

MRL Polymer Characterization Facility

Manual Purpose: - this manual serves two basic purposes:

1. It is the basic laboratory safety manual for UCSB

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

Manual Structure:

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

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

Section III: Appendix. Includes further information on PI responsibilities, laboratory inspections, and the GHS classification system, as well as a list of particularly hazardous substances.

Section I: Laboratory-Specific Chemical Hygiene Plan: Standard Operating Procedures

Introduction:

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

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

The second part of the required safety training is this Chemical Hygiene Plan (CHP). Everyone who wishes to work in the Polymer Facility needs to read this Chemical Hygiene Plan. After reading the CHP, people need to document that they have read it. This should be documented by signing the Google Form MRL Polymer Facility Chemical Hygiene Plan User Agreement (UCSB), which I will send to you. The link can also be found in this document.

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

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

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

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

Required Training:

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

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

Safety training begins with the UCSB EH&S "UC Lab Safety Fundamentals". Everyone working in the lab is required to take this course before beginning lab work. The EH&S Lab Safety class is offered online and in-Person twice quarterly. The online course and the in-person schedule are posted at: http://learningcenter.ucsb.edu

After the EH&S Lab Safety course, people working in the MRL Polymer Lab need to read:

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

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

As much as it may seem, all of the above is just the foundation of the laboratory safety training. Everyone working in the lab must do the appropriate inquiry, literature research, and thought to 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. I am available to answer questions and to help, but you ultimately will be the one carrying out the work, so you will need to be familiar with the potential hazards.

General Laboratory Information

Laboratory Supervisor (PI): Prof. Christopher Bates, ENG II 1518
Laboratory Technical Director (TD): Dr. Rachel Behrens, MRL 2003, x5850
Polymer Lab Assistant: Mr. Cesar Rodriguez, MRL 2244

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

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

Dr. Amanda Strom, MRL 2066F, phone: x7925 (DSR)
Sara Bard, MRL 2066E, phone: x8519 (DSR alternate)
Dr. Rachel Behrens, MRL 2003, x5850 (DSR alternate)

Location of Department Safety Bulletin Board: MRL 2042

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

Emergency Information

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

- **Evacuation procedures** (e.g., close fire doors, secure certain equipment, etc.)

Leave the room and the building as quickly as possible. Proceed to the Emergency Assembly area which is north of the MRL Building at the south west corner of Eng. II. If time take valuable personal property.

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

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

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

In the Event of an Incident
All incidents must be reported.

Report right away:

- Fatality
- Inpatient hospitalization
- Loss of any body part (e.g., fingertip)
- Serious injury (medical treatment beyond first aid)

Report within 24 hours
Any other types of incidents (examples below):

- Any other type of bodily injuries regardless of severity
- Needle stick injuries and cuts from sharp objects that are contaminated with another person's blood or other potentially infectious material
- Loss of consciousness
- Incidents which disrupt the normal work process
- Use of any safety equipment: emergency eyewash or shower, fire extinguisher, spill kits, first aid kits, satellite communicators (SOS button)
- Hazardous chemical exposure
- Large hazardous chemical spills (more than 1 L)
- Fire
- Event during which property damage or disruption of facility operations occurred
- Near miss
- Behavioral problems, emotional unwellness, distress
- Any unsafe conditions, hazards.

In the Event of an Injury
Per campus policy, all **significant injuries must be documented** with "Create a Claim" by completing an Employee First Report (EFR). This is necessary for potential reimbursement for personal medical costs, or Worker's Compensation Claims. For direction on the reporting procedure, visit: https://www.ehs.ucsb.edu/sites/default/files/docs/wc/EFRCreateAClaim.pdf

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

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

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

Near Misses
OSHA defines a near miss as "an unplanned event that did not result in injury, illness or damage – but had the potential to do so." A near miss is also referred to as a "close call" or "good catch" and must be reported within 24 hours.

Near misses can include:

- minor injury (medical attention not needed or first-aid was self-applied)
- laboratory equipment failure
- unexpected chemical reaction
- non-compliance with safety policies or procedures
- Event which had the potential to cause property damage or disruption of facility operations

For further information on near misses or to report one, visit here.

- ***Other Lab-specific emergency information***

The MRL Emergency Operations Plan: http://www.mrl.ucsb.edu/mrl-emergency-operations-plan

- **Spill cleanup materials** (e.g., location, contents, maintenance, procedures, etc.)

Chemical spill cleanup kits are kept in 1043 MRL on top of the refrigerator and in 1050 MRL under the cabinet by the FBS log in computer. Please contact technical director if more supplies are needed.

- **Laboratory monitors or alarms** (e.g., operation, response, maintenance, etc.)

There are oxygen level monitors in MRL 1051 and 1052. This is maintained by the technical director.

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

- **First-aid kit** (e.g., location, contents, maintenance responsibility, etc.) First-aid kits are located in each lab:

MRL 1043: On top of the refrigerator by the hallway exit
MRL 1050: Two are located near the hallway exit
MRL 1051: On bookcase by door to hallway
MRL 1052: On desk by balance

It is responsibility of the Lab TD to maintain the first aid kits.

Health and Safety References:

Here is a short list of the title and location of health and safety reference materials (reference books-1, Safety Data Sheets-2, experimental protocols, etc.) associated with the lab which employees may use to aid them in their work.

	Reference	Location
1.	Laboratory Safety Program/Chemical Hygiene Plan	online only
2.	Paper Copies of (M)SDS	1043, 1050 MRL
3.	Electronic Copies of select (M)SDS	computers in 1043, 1050, 1052, and 1053 MRL
4.	Merck Index	2003 MRL
5.	Handbook of Chemistry and Physics	2003 MRL
6.	Fisher Safety- Safety Products Reference Manual	2003 MRL

The book entitled: *Prudent Practices in the Laboratory* by the National Research Council is widely considered to be a definitive reference. It can be purchased but is also available free on-line in a searchable format. It is recommended that all lab workers have ready access to this important reference.

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

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

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

*Labs are encouraged to maintain hard copies of their own SDS for the hazardous chemicals they routinely use, or at minimum, have this link bookmarked by all individuals in the lab.

General Laboratory and Chemical Safety:

In addition to the guidelines provided below, it is recommended that you go over the Laboratory Safety Self-Checklist.

MRL Polymer Characterization Facility

General

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

Electrical Safety

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

Gas cylinder handling

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

Chemical Safety

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

Cleaning the lab

- Properly dispose of old or unwanted chemicals or any unnecessary items.
- Damp wipe all bench-tops until clean and in particular areas near weighing stations.
- Clean up inside fume hoods.
- Look inside all cabinets for leftover waste and any storage hazards.
- Recycle paper and cardboard properly.
- Unused or spare equipment should be stored in a designated storage room/area.
- Equipment or furniture should not block walkways, electrical panels, or emergency eyewash or showers.

- Check emergency egress path is maintained (minimum exit pathway in rooms is 28 inches).
- Verify the lab(s) are clean, organized and anything else required to make lab look professional.
- Check for trip and slip hazards (oil leaks from pumps, electrical cords or hoses across walking path).

Fume Hoods

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

Disposal of Sharps

- Lab glassware not contaminated by hazardous materials (eq. Pasteur pipettes) can be placed into labeled "Broken Glass" trash box or other sturdy container. When full, dispose of contents into the red sharps bins outside by the trash and recycling dumpsters.
- Sharps contaminated with chemicals should be placed into a sharps container and labeled as "Sharps contaminated with (chemical name)" and sent to EH&S for disposal. (See SOP: Sharps Safety and Section II, Chapter 3: Handling Hazardous Chemicals)

Chemical Waste Disposal

- Hazardous waste regulations are stringent and penalties for violations can be severe. Santa Barbara County inspects UCSB labs for compliance on a regular basis.
- Store chemical waste in a designated area. Label area as, "Hazardous Waste Storage Area".
- Store chemicals in containers compatible with, and durable enough for, the waste. Liquid must be in screw top containers. Do not overfill container, allow for expansion.
- Labeling- identify waste by proper chemical name.
- Deface existing labels when reusing containers.
- Label and date containers when the first drop of waste is added. Hazardous waste shall be disposed within 9 months. Labels are available in all science storerooms and in the laboratory.
- Chemicals may not be disposed in a regular trash, sink disposal, or allowed to evaporate. (See Section II, Chapter 3: Handling Hazardous Chemicals)

Chemical Spills

- For detailed instructions, please refer to Chemical Spills in Section II, Chapter 4 of this document
- Clean up a spill using the proper equipment (please use spill kit contents- available in 1043 and 1050 MRL).
- Cal EH&S 24-hour line 805-893-3194 if necessary.

Safe storage of chemicals

- In earthquake-prone areas like Santa Barbara, it is particularly vital that chemicals be stored safely. Use a secondary container (plastic tub) large enough to contain a spill of the largest container).
  - Store or waste using the following criteria: Flammables, Corrosives, Oxidizers, Carcinogens, Water reactive, Toxics, Pyrophorics. (Globally Harmonized System (GHS) Pictograms and their meanings can be found in Section II, Chapter 3: Chemical Hazard Classes)
- Acids- store bottles in the acid cabinets, segregate oxidizing acids from organic acids, and flammable materials. (E.g. nitric acid must be stored in a separate bin.)
- Segregate acids from bases, and from active metals such as sodium, etc.
- Segregate acids from chemicals which could generate toxic gases such as sodium cyanide, etc.
- Flammable store in approved storage cabinet. Keep away from any source of ignition (flame, heat or sparks).
- Oxidizers-react violently with organics. Keep away from flammables, from reducing agents, store in a cool, dry place.
- Pyrophoric substances-spontaneously ignite in air. Some organo-aluminum compounds, silane, divided metals, phosphorus yellow. Rigorously exclude air and water from container. Store away from flammables, store in a cool dry place.

Refrigerators and Freezers

- There are two fridges/freezers in the lab (MRL 1043 and 1050). They are designed for the storage of flammables but are not owned by the Polymer Facilities, so chemical storage for Polymer Facility users should be done so in their own lab space.
- *No food or drink must be stored in any of the fridges in the lab.*
- Minimize the time that this freezer is opened, as moisture from the air rapidly condenses on it.

Personal Protective Equipment (PPE)

Long Pants and closed-Toe Footwear

- Long pants and closed-toe footwear must be worn in the lab at all times!

Lab coats

Laboratory coats are required to be worn while working on, or adjacent to, all hazardous chemicals, biological or unsealed radiological materials. It is imperative to consider the nature of the work performed when choosing a lab coat. In general, you must wear a flame-resistant (blue) lab coat when working in the Main MRL Labs,

including MRL 1043 and 1050.

- Note that "standard" lab coats are typically made from a polyester/cotton mix and are not suitable for work with flammables.
- Laboratory coats must not be worn outside of a laboratory unless the individual is traveling directly to an adjacent laboratory work area.
- Each person should have their personal lab coat, which they will receive as part of the PPE provided by UCSB to new lab workers. These laboratory coats must be appropriately sized for the individual and be buttoned to their full length. Laboratory coat sleeves must be of a sufficient length to prevent skin exposure while wearing gloves.
- Lab coats must not be cleaned at home nor in public laundry facilities. Rather, a professional cleaning service must be used. See the information at the lab coat laundering drop off station in the MRL (near the restrooms on the first floor). Any clothing that becomes contaminated with hazardous materials must be decontaminated before it leaves the laboratory. If a lab coat is very heavily contaminated, it should be packaged safely and disposed of as hazardous waste.

Gloves

- Protective gloves must be worn while utilizing any hazardous chemical, biological or unsealed radiological material. These gloves must be appropriate for the material being used and conditions under which such use takes place (e.g., extreme cold).
- A glove recycling program has just been initiated to help reduce our environmental impact. There will be specific receptacles in each of the participating labs that are only for *uncontaminated* and powder-free nitrile, latex, and vinyl gloves
  - ***Uncontaminated*** can include light contamination from non-toxic chemicals as long as they are rinsed and mostly dry prior to disposal
  - **DO NOT** include any gloves that should be considered biohazardous or hazardous waste
- 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: https://www.ehs.ucsb.edu/programs-services/lab-safety-chemical-hygiene/labsafety-chp/sec2/selecting-proper-gloves

Spills and Exposure to Hazardous Chemicals

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

- Administer First Aid as needed
- Warn people in the area

- Evacuate the area if needed
- Notify 9-911
- Notify the Departmental Safety Representative (DSR) or alternate DSR as soon as feasible

Exposure to Chemicals First Aid

If a chemical splashes in someone's eye, rinse with copious amounts of water for a minimum of **10 minutes**. Small burns or splashes with corrosive chemicals on the skin are also flushed with water for five minutes. Use the emergency showers if a person's hair or clothing has caught fire (rolling the person on the floor is another option for extinguishing flames) or in the event of a larger spill of a hazardous chemical on skin or clothing.

Some Best Lab Practices

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

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

Leaving Lab

On completion of your work in the Polymer Facility you will need make a way for next person and put your gear back into circulation. Be sure to do following:

- Let the technical director know when you are leaving a few weeks before you leave.
- Dispose any samples that do not need to be archived. Transfer your samples to your supervisor labs.
- Empty out all drawers which you have been using. Any equipment and glassware that has been assigned to you should be back into circulation.
- Any hazardous/chemical waste you have should be labeled and then placed into the waste chemical area.
- Any reagents in your possession should go back to someone in your group.
- Return keys to Sylvia Vogel (MRL 2066G). Let your PI or lab manager know how to reach you.

Ten Commandments of Safety:

- Thou shalt wear thy safety glasses, as with all other personal protective equipment that shall be required.
- Thou shalt chain all of thy gas cylinders securely with chain of welded link. When the earth shall shake, thy chemicals, bookshelves, and heavy goods must not fall down to the earth or upon thy head.
- Thou shalt not store thy chemicals alphabetically, but only compatibles upon compatibles.
- Thou shalt not smoke within the laboratory. Neither shall thou confuse the laboratory with a place of nourishment.
- Thou shalt never dump thy waste chemicals into the drain. Neither shall thou place any sharp waste, including broken glass, razor blades, nor needles, in the regular trash cans inside the laboratory. Thou shalt place all sharp waste into the dumpster or a special container.
- Thou shalt label all of thy chemicals and samples with thy name and the date. Thou shalt never leave unknown and unmarked bottles of chemicals or samples for thy neighbor.
- Thou shalt purchase only the minimum chemicals for thy needs. Thou shalt not covet thy neighbor's chemicals, and thou shalt share thy chemicals with thy neighbor.
- Thou shalt not have multiple extension cords in series.
- Thou shalt not deliver oxygen in plastic tubing, lest the fires of Hell visit upon thy experiment.
- Thou shalt know what thou are doing and about the hazards thou faceth. Thou shalt never toil in the laboratory until thou hast studied and trained about safe work practices.

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

Communicating Safety and other Lab Issues

You should report any procedure, condition or situation that you consider to be unsafe, or potentially unsafe. Except for an actual emergency, the best way to communicate a safety problem is to write an email to the DSR or alternate DSRs, 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 technical director.

Background: Standard Operating Procedures

Per Cal/OHA regulations, a Chemical Hygiene Plan must include Standard Operating Procedures (SOPs) that pertain to the storage and use of the hazardous chemicals in your laboratory. The following steps should be followed in order to complete this requirement.

1. **Determine which SOPs you need:** Compare your chemical inventory and lab processes against the UCSB Standard Operating Procedure Template. There, SOP templates are available for most hazard classes, a number of specific chemicals, and certain laboratory processes. Additionally, a blank SOP template is available. If you require an SOP template that is not available in the library, feel free to contact EH&S for assistance.
2. **Customize the SOP templates you selected:** Sections in red on the template must be filled out to reflect the details specific to your research group. Specifically, the *Laboratory Specific Information* section must be filled out to generate a Cal/OSHA compliant SOP. This can be very detailed if so desired, but in many cases, this can be satisfied by just a few sentences. Examples and blank template are here.
3. **Add completed SOPs to the end of this document.**
4. **PI completes the Certification Page below**
5. **Laboratory workers review the SOPs, as well as the UCSB Chemical Hygiene Plan, and sign off on the Laboratory Worker Training Record page below.**

Standard Operating Procedure Library Certification Page

PI/Laboratory Supervisor Name:

Applicable Laboratory Locations (Building, Room #):

PI/Laboratory Supervisor Signature:

I certify that I have reviewed and approve the attached Laboratory Specific Chemical Hygiene Plan with Standard Operating Procedures for laboratory operations being conducted in the locations noted above.

Signature:_____

Laboratory Worker Training Record:

UCSB Chemical Hygiene Plan and Laboratory Specific Chemical Hygiene Plan with Standard Operating Procedures

PI/Laboratory Supervisor:_____

The following laboratory workers have reviewed and understand the contents of the UCSB Chemical Hygiene Plan and this laboratory's Laboratory Specific Chemical Hygiene Plan with Standard Operating Procedures:

Name (Please print)	**Signature**	**Date**

Standard Operating Procedure General Information

The following apply to all chemicals unless specifically noted in the customized SOP. Any additional requirements will also be noted in the SOP:

Engineering Controls:

Fume Hood: All chemicals should be transferred and used in an annually certified chemical fume hood, in an effort to keep exposures as low as possible. If your specific protocol does not permit the handling of certain chemicals in a fume hood, contact EH&S to determine whether additional *respiratory protection* and/or *specialized local ventilation* is warranted.

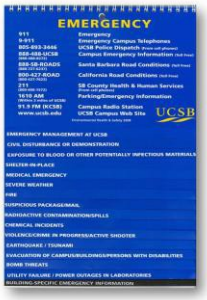
Safety Shielding: Shielding is required of there is significant risk of explosion, implosion or splash. This risk can be due to the nature of the chemicals involved, the reaction conditions (temperature, pressure) or scale.

Storage: All chemicals should be stored upright, tightly sealed, and in a cool, dry, and well ventilated space. Segregate incompatible materials from each other based on information from the SDS and as described in the Chemical Hygiene Plan. All containers must be labeled in English with the name of the material (no formulas or acronyms) and all relevant hazard statements (e.g. corrosive, flammable, etc.)

First Aid and Emergencies:

Fire: DO NOT use water to put out a fire. A class ABC fire extinguisher can be used to extinguish most laboratory fires. If pyrophoric or water reactive metals are involved in the fire, use a class D extinguisher.

Spills: Evacuate the location where the spill occurred. Notify others in the areas of the spill, including your supervisor. Notify EH&S in case of personal exposure. If the spill is <1 Liter and of a known material of limited toxicity, flammability and volatility, post someone just outside of the spill area, don proper PPE, and clean the spill following the procedure in the Chemical Hygiene Plan Section II, Chapter 4 and the UCSB Emergency Flip Chart.
Otherwise, call EH&S at X3194, or 911 if there is immediate danger to life, health or property.



Exposures:

Skin or eye contact: Remove contaminated clothing and accessories. Flush affected area with water for 15 minutes. If symptoms persist, get medical attention.

Inhalation: Move person to fresh air. If symptoms persist, get medical attention.

Ingestion: Rinse mouth with water. If symptoms persist, get medical attention.

Decontamination: Wear proper PPE, decontaminate equipment and benchtops using soap and water. Dispose of contaminated paper towels as hazardous waste, following the UCSB hazardous waste procedures described in the UCSB Chemical Hygiene Plan.

Waste Disposal: Refer to Section II, Chapter 3 of the UCSB Chemical Hygiene Plan.

Polymer Facility Specific Standard Operating Procedures Following This Page.

SOPs included in this section

1. Carcinogens, Reproductive Toxins and Acute Toxins
2. Dichloromethane
3. Irritants and Sensitizers
4. Peroxide-Forming Chemicals
5. Flammables
6. Corrosives
7. Oxidizers
8. Nitric Acid
9. Cryogens
10. Compressed Gases
11. Vacuum Systems
12. High-Pressure Reaction Vessels
13. Ethylene Oxide
14. Sharps Safety

Standard Operating Procedure

Carcinogens, Reproductive Toxins and Acute Toxins

(Cal/OSHA Particularly Hazardous Substances)

Overview

Three classes of hazardous chemicals are defined by Cal/OSHA as 'Particularly Hazardous Substances' (PHS):

- *Carcinogens* are materials that have the potential to cause cancer.
- *Reproductive Toxins* are materials that affect reproductive capabilities, including *mutagenesis* (causing chromosomal damage), *teratogenesis* (effects on the fetus), and adverse effects on sexual function and fertility.
- *Acute toxins* are substances that may be fatal as a result of a single exposure ($LD_{50} \leq 50$ mg/kg (oral), 200 mg/kg (dermal), 500 ppm (inhaled).

If the carcinogen you are using is a Listed Carcinogen (8 CCR §5209), EH&S will contact you upon your ordering of that material to address safety requirements that go beyond this SOP.

Special Handling and Storage Concerns

Personal Protective Equipment

- Traditional lab coat. Flame resistant if material is flammable.
- Nitrile or Neoprene Gloves are adequate for possible incidental exposure in most cases. Consult a glove chart if the specific material in use is particularly hazardous, or if the risk of contact is high.
- ANSI Z87.1-compliant safety glasses. Safety goggles if a splash hazard is present.

Special Storage Requirements

Store Particularly Hazardous Substances away from other chemicals. Each container must include all applicable hazard warnings. It is recommended that the appropriate GHS pictogram also be on the container. The storage area must be within a PHS designated area, and all containers stored in secondary containment.

Engineering Controls

Fume Hood: All PHS *must* be handled in a fume hood. If this is not possible due to scale or equipment, contact EH&S to determine alternate ventilation approaches or respiratory protection needs.

Special Handling Considerations

Only use PHS in a designated area. This designated area may be the entire laboratory, or only a portion of it. Note that the information in this SOP describes the baseline requirements for PHS. You will need to generate or review a chemical-specific SOP if the material you are handling has:

- *Unique properties*: e.g. cyanide salts, where the risk of exposure varies greatly with pH.
- *Multiple hazards*: e.g. azide salts, which are highly toxic and potentially explosive.
- *Extreme hazards*: e.g. methyl mercury, which penetrates the skin and is lethal in tiny doses.

Decontamination

This SOP covers a wide range of materials. Consult the SDS for any possible special decontamination procedures.

Waste Management

Note that some PHS waste may be considered *Extremely Hazardous Waste* and should be handled as described in the UC Santa Barbara Chemical Hygiene Plan. This includes disposing of the emptied original container as hazardous waste through EH&S.

First Aid and Emergencies

Spill

Treat all spills of these materials as a major spill. Do not attempt to clean up the spill yourself. Notify others in the area of the spill, including your supervisor. Evacuate the area and call 911. Remain on-site at a safe distance to provide detailed response to first responders. Report any exposures to EH&S.

Fire

Standard measures apply.

Personnel Exposure

Skin or eye contact: Remove contaminated attire. Flush affected area with water for 15 minutes. If symptoms persist, get medical attention.

Inhalation: Move person to fresh air. Get medical attention immediately.

Ingestion: Rinse mouth with water. Get medical attention immediately.

Laboratory Specific Information

Prior Approval Required

- ☒ **NO**
- ☐ **YES (describe):**

Designated Area (required for Particularly Hazardous Substances)

- ☐ **Entire Laboratory Area**
- ☒ **Other (describe): MRL 1043, MRL 1050**

Experimental Conditions of Use

Temperature Range: Room Temperature

Pressure Range: 1 atm

Scale Range: 1-4L

Other Relevant Details: Specific Chemicals used: Chloroform, Dichloromethane, Methanol

Standard Operating Procedure

Dichloromethane

(Methylene Chloride)

Overview

Dichloromethane is an anesthetic. Inhaling the vapor can cause light-headedness leading to unconsciousness and even death. Other symptoms of exposure include skin, eye and respiratory tract irritation. Strong evidence supports that dichloromethane is a human carcinogen upon chronic exposure. Its high volatility makes it imperative that it be handled in a fume hood or other vapor-capturing device. Unlike many organic solvents, dichloromethane is not flammable. Dichloromethane is considered a Particularly Hazardous Substance (PHS).

Special Handling and Storage Concerns

Personal Protective Equipment

- Standard Lab Coat.
- Butyl, Viton and polyvinyl alcohol gloves are recommended. Standard nitrile and neoprene lab gloves are NOT recommended.
- ANSI Z87.1-compliant safety glasses. Safety goggles if a large splash hazard is present.

Special Storage Requirements

Dichloromethane is a PHS. Each container must include all applicable hazard warnings. It is recommended that the appropriate GHS pictograms also be on the container. The storage area must be within a PHS designated area, and all containers stored in secondary containment.

Engineering Controls

Fume Hood: Dichloromethane *must* be handled in a fume hood. If this is not possible due to scale or equipment, contact EH&S to determine alternate ventilation/isolation approaches or respiratory protection needs.

Special Handling Considerations

Only use dichloromethane in a PHS in a designated area. This designated area may be the entire laboratory, or only a portion of it.

Decontamination

Standard decontamination procedures apply. Use great caution in avoiding exposure.

Waste Management

Standard waste disposal procedures apply.

First Aid and Emergencies

Spill

Treat all spills of benzene as major spills. Do not attempt to clean up the spill yourself. Notify others in the area of the spill, including your supervisor. Evacuate the area and call 911. Remain on-site at a safe distance to provide detailed response to first responders. Report any exposures to EH&S.

Fire

Dichloromethane is not itself flammable. Standard firefighting measures apply

Personnel Exposure

Skin or eye contact: Remove contaminated attire. Flush affected area with water for 15 minutes. If symptoms persist, get medical attention.
Inhalation: Move person to fresh air. Consult a physician is symptoms persist.
Ingestion: DO NOT induce vomiting. Rinse mouth with water. Consult a physician.

Laboratory Specific Information

Prior Approval Required

- ☒ **NO**
- ☐ **YES (describe):**

Designated Area

- ☐ **Entire Laboratory Area**
- ☒ **Other (describe): MRL 1043, MRL 1050, MRL 1051**

Experimental Conditions of Use

Temperature Range: Room Temperature

Pressure Range: 1 atm

Scale Range: >1L

Other Relevant Details:

Standard Operating Procedure

Irritants and Sensitizers

Overview

Irritants are chemicals that, while not corrosive, can cause a reversible inflammatory effect on living tissue at the site of skin, eye, mucous membrane and respiratory tract contact.

Sensitizers are chemicals which induce an allergic reaction in a substantial portion of the population after repeated exposure. *In the most severe cases this can include life-threatening anaphylaxis.*

Although the mechanism of their toxicity varies, these materials are similar in that their effects are generally short-term and reversible and occur from skin contact or inhalation. Therefore, similar precautions are taken for both these classes of chemicals.

Special Handling and Storage Concerns

Personal Protective Equipment

- Traditional white lab coat.
- Nitrile or neoprene gloves are adequate for possible incidental exposures. Reduce skin exposure by tucking lab coat sleeve into glove.
- ANSI Z87.1-compliant safety glasses. Safety googles if a large splash hazard is present.

Engineering Controls

Exposure to skin, eye, mucous membrane and respiratory tract must be kept to an absolute minimum. Therefore, *always* use a fume hood or a glove box, or other enclosure/isolation device. Consult EH&S for an assessment of the possible alternative approaches to ventilation/isolation.

Special Handling Considerations

If possible, weigh chemicals at a balance that is located in a fume hood or similar locally ventilated location.

Waste Management

Standard procedures apply.

First Aid and Emergencies

Personnel Exposure

Standard procedures apply. For sensitizers, be aware that sensitization requires repeated exposures, and therefore symptoms may appear for the first time or increase in severity compared to previous exposure incidents.

Laboratory Specific Information

Prior Approval Required

☒ **NO**

☐ **YES (describe):**

Designated Area

☒ **Entire Laboratory Area**
☐ **Other (describe):**

Experimental Conditions of Use

Temperature Range: Room Temperature

Pressure Range: Standard Pressure

Scale Range:

Other Relevant Details:

Standard Operating Procedure

Peroxide-Forming Chemicals

Overview

Peroxide-Forming chemicals are flammable organic liquids which are capable of forming potentially explosive organic peroxides (R-O-O-R') upon exposure to air or other oxidizing impurities. Organic peroxides are among the most hazardous substances handled in the laboratory. They are sensitive to oxygen, heat, friction, light, strong oxidizers, and reducing agents, and are far more shock sensitive than most primary explosives such as TNT. It is particularly dangerous to allow these materials to evaporate to dryness, such as during distillation. **ETHERS** are the peroxide-formers most common in the laboratory.

Special Handling and Storage Concerns

Personal Protective Equipment

- Flame Resistant Lab Coat.
- Nitrile or Chloroprene gloves are adequate for incidental exposure. Consult a glove chart if large splashes or immersion are possible.
- ANSI Z87.1-compliant safety glasses. Safety goggles if a large splash hazard is present.

Special Storage Requirements

Store in airtight containers, and in a flammable storage cabinet or refrigerator rated for flammable materials. Containers larger than 4 L are not recommended, due to the time-sensitivity of these materials. *Date containers upon receipt and opening*. As noted in the UC Santa Barbara Chemical Hygiene Plan:

- Class A peroxide formers must be discarded within 3 months of receipt or formation:
  (Divinyl ether, divinyl acetylene, isopropyl ether, sodium and potassium amide, potassium metal.)
- Class B peroxide formers must be discarded 6 months after opening, 12 months if they contain an inhibitor:
  (Diethyl ether, Furan, tetrahydrofuran, dioxane, etc.)
- Class C peroxide formers must be discarded after 5 days, 12 months if they contain an inhibitor:
  (Acrylic acid, ethyl acrylate, methyl methacrylate, styrene, vinyl acetate, vinyl chloride, vinyl pyridine)

Engineering Controls

Diethyl ether must be used in a fume hood at all times. Solvent mixtures for purification equipment that contain tetrahydrofuran or other higher boiling ethereal solvents must be prepared in the fume hood but can be used in equipment outside the hood as long as the reservoir container is sealed.

Special Handling Considerations

Static Electricity Risk: Large containers of peroxide-forming chemicals are discouraged due to the time-sensitivity of these materials. If metal drums are used (≥20 L), they should always be grounded, and they should be bonded to the receiving container during transfer. Flammable storage cabinets are equipped with a grounding system that should be connected to a building ground. Transferring these materials between unbonded metal containers, or between plastic containers may lead to a fire hazard due to static electricity buildup.

Decontamination

This SOP covers a wide range of materials. Consult the SDS for any possible special decontamination procedures.

Laboratory Specific Information

Prior Approval Required

- ☒ **NO**
- ☐ **YES (describe):**

Designated Area

- ☐ **Entire Laboratory Area**
- ☒ **Other (describe): MRL 1043, MRL 1051, MRL 1050**

Experimental Conditions of Use

Temperature Range: Room Temperature

Pressure Range: 1 atm

Scale Range: 1-4L

Other Relevant Details: Specific Chemical Used: Tetrahydrofuran

Standard Operating Procedure

Flammables

Overview

A flammable solvent is defined by the National Fire Protection Agency (NFPA) as having a flashpoint below 100 °F (37.8 °C). The lower the flashpoint, the more easily the liquid can be ignited. Their presence in the laboratory in fairy large volumes greatly exacerbates the fire risk posed by these materials. The large volumes also increase the risk posed by any other hazards associated with the specific material (toxicity, carcinogenicity, etc.)

Special Handling and Storage Concerns

Personal Protective Equipment

- Flame Resistant Lab Coat.
- Nitrile or Neoprene Gloves are adequate for possible incidental exposure. Consult a glove chart if large splashes or immersion are possible.
- ANSI Z87.1-compliant safety glasses. Safety goggles if a large splash hazard is present.

Special Storage Requirements

Store in a flammable storage cabinet with self-closing hinges, or in a refrigerator rated for flammable storage. Any container larger than 1 gallon (4L) must be stored in a flammable storage cabinet at all times. *The maximum amount of flammable material allowed outside of these storage areas is 10 gallons*. Store flammable materials away from oxidizers and combustible materials. Flammable cabinets must be labeled clearly with the statement "Flammable – Keep Fire Away".

Engineering Controls

If your protocol does not permit the handling of these materials in a **fume hood**, EH&S *must* be contacted to assess alternate ventilation options.

Special Handling Considerations

Static Electricity Risk: Large containers of flammable liquid ($\geq$ 20L) should always be grounded and should be bonded to the receiving container during transfer. Flammable storage cabinets are equipped with a grounding system that should be connected to a building ground. Transferring these materials between unbonded metal containers, or between plastic containers may lead to a fire hazard due to static electricity buildup.

Decontamination

This SOP covers a wide range of materials. Consult the SDS for any possible special decontamination procedures.

Waste Management

Segregate halogenated from non-halogenated organic solvent waste.

First Aid and Emergencies

Spill

A number of organic solvents are carcinogenic (e.g. benzene, methylene chloride, formaldehyde). Do not attempt to clean up a spill of these materials. Consult the SDS to confirm toxicity information, then call

EH&S for assistance.

Fire

Standard firefighting measures apply.

Personnel Exposure

Standard measures apply.

Laboratory Specific Information

Prior Approval Required

- ☒ **NO**
- ☐ **YES (describe):**

Designated Area

- ☐ **Entire Laboratory Area**
- ☒ **Other (describe): MRL 1043, MRL 1050, MRL 1051**

Experimental Conditions of Use

Temperature Range: Room Temperature

Pressure Range: Standard Pressure

Scale Range: 1-20L

Other Relevant Details: Specific chemical: Methanol

Standard Operating Procedure

Corrosives

Overview

Corrosives are materials, acids and bases, that cause the destruction of exposed tissues and mucous membranes. Rapid damage can occur to eyes and skin, as well as to the respiratory tract (inhalation) and gastrointestinal tract (ingestion). Strong corrosive solutions have a pH <2.5 (strong acids) or >11 (strong bases) and cause damage via the reaction of hydroxide ions (OH^-) or hydronium ions (H_3O^+) with tissue. *This SOP does not cover oxidizing acids (e.g. Nitric acid, perchloric acid), or corrosives with other highly hazardous properties (e.g. hydrofluoric acid). If using, please see the SOP specific to these materials.*

Special Handling and Storage Concerns

Personal Protective Equipment

- Traditional white lab coat. Chemical-resistant apron when working with large volumes.
- Nitrile or neoprene gloves are adequate for possible incidental exposure. Consult a glove chart if large splashes are possible. *No latex gloves!*
- ANSI Z87.1-compliant safety glasses. Safety goggles or safety goggles plus face shield if a large splash hazard is present.

Special Storage Requirements

Acids and bases must be segregated in storage. Store in chemically-resistant secondary containers (e.g. polypropylene tubs). Store below eye level. Segregate from active metals such as sodium, potassium, magnesium, etc. Use a corrosives storage cabinet if available.

Engineering Controls

If your protocol does not permit the handling of these materials in a fume hood, assess the volatility of the material (e.g. hydrochloric acid) and contact EH&S if alternative ventilation options are necessary.
An eye wash/safety shower unit *must* be within a 10 second walk (about 35 feet) from where corrosives are being handled, with only a single intervening door, opening in the direction of travel.

Special Handling Considerations

When forming solutions/dilutions, to avoid serious splatter risk ***add the corrosive to water, and never the reverse***.
Acids can react with metals, releasing flammable hydrogen gas.

Waste Management

Segregate acids of pH $\leq$2, bases of pH $\geq$12.5, and oxidizing acids.

First Aid and Emergencies

Spill

It is best practice to keep acid and base neutralizers in the laboratory spill kit if corrosives are used (e.g. sodium bicarbonate, citric acid).

Personnel Exposure

Standard measures apply. Pay extra attention to flushing affected skin/eyes with water for a full 15 minutes using an eyewash/safety shower unit.

Laboratory Specific Information

Prior Approval Required

- ☒ **NO**
- ☐ **YES (describe):**

Designated Area

- ☐ **Entire Laboratory Area**
- ☒ **Other (describe): MRL 1043, MRL 1051**

Experimental Conditions of Use

Temperature Range: Room Temperature

Pressure Range: 1 atm

Scale Range: >1L

Other Relevant Details: Chemical specifically used: 0.1% solution of formic acid

Standard Operating Procedure

Oxidizers

Overview

Oxidizers are chemicals that cause or increase the intensity of the combustion of other materials. This can occur at room temperature, or with slight heating. Strong oxidizers are capable of forming explosive mixtures when mixed with combustible, organic, or easily oxidized material.

Special Handling and Storage Concerns

Personal Protective Equipment

- Flame resistant lab coat.
- Neoprene or butyl rubber gloves are adequate for possible incidental exposure. Consult a glove chart if a high risk of skin contact is present.
- ANZI Z87.1-complaint safety glasses or. Safety goggles if a large splash hazard is present.

Special Storage Requirements

It is essential that all strong oxidizers be stored separately from all chemicals with which they may react. Do not store oxidizers directly on wooden shelves. Ensure secondary containment and segregation of incompatible chemicals. Also, follow any substance-specific storage guidance provided in Safety Data Sheet (SDS) documentation.

Engineering Controls

Fume hood: Handle oxidizers in a chemical fume hood to minimize the potential for the spread of a fire should one occur. Note that the handling of perchloric acid may require the use of a specialized perchloric acid fume hood, or an alternative vapor-capturing device. See the Perchloric Acid SOP template for more information.

Blast shield: A blast shield is recommended whenever there is a risk of explosion. Examples of strong oxidizers with high explosion risk include: hydrogen peroxide (52-91% by weight), fuming nitric acid, perchloric acid (60-72% by weight), etc. Refer to the SDS of the material in question for specific information on its oxidizing potential.

Special Handling Considerations

Rigorously label all reagent and waste containers. Inadvertent mixing of oxidizers and organic material is one of the most common causes of laboratory explosions.

Decontamination

This SOP covers a wide range of materials. Consult the SDS for any possible special decontamination procedures.

Waste Management

Carefully segregate oxidizer waste from all organic waste, as combining these waste streams is a serious explosion hazard. Collect oxidizer waste in as small a container as is practical, and schedule a pick-up with EH&S as soon as the container is full, or no further oxidizer waste will be generated. Vented caps must be used on containers for waste streams of oxidizing inorganic acids or pressure-generating materials.

First Aid and Emergencies

Spill

Standard measures apply

Fire

Standard measures apply

Personnel Exposure

This SOP covers a wide range of materials. Consult the SDS for any possible special considerations.

Laboratory Specific Information

Prior Approval Required

- ☒ **NO**
- ☐ **YES (describe):**

Designated Area

- ☐ **Entire Laboratory Area**
- ☒ **Other (describe): MRL 1043, MRL 1050**

Experimental Conditions of Use

Temperature Range: Room Temperature

Pressure Range: Standard Pressure

Scale Range: >1L

Other Relevant Details:

Standard Operating Procedure

Nitric Acid



Overview

Nitric acid is an extremely corrosive acid and **strong oxidizing agent**. It may be harmful if ingested, inhaled, or absorbed through the skin. It can cause severe skin and eye burns resulting in irreversible damage. It is extremely destructive to the tissue of the mucous membranes and the upper respiratory tract.

As a strong oxidizing agent, it can cause **violent explosions** when combined with reducing agents such as organic solvents and reagents. Therefore great care must be taken to store it separately from organic acids, flammable and combustible liquids (such as organic solvents), and organic reagents in general. Nitric acid waste must also be segregated from all other organic waste. **Combination of nitric acid waste with other non-compatible waste streams is a major cause of laboratory explosions**.

Special Handling and Storage Concerns

Personal Protective Equipment

- Traditional white lab coat. Chemical resistant apron when working with large volumes.
- Nitrile or neoprene gloves are adequate for possible incidental exposure. Viton gloves if large splashes are possible. *No latex gloves!*
- ANSI Z87.1-compliant safety glasses. Safety goggles or safety goggles plus face shield if a large splash hazard is present.

Special Storage Requirements

Store separately from other laboratory chemicals with which it may react. For oxidizing acids such as nitric acid this includes all organic materials including organic acids, reducing agents, bases, alkali metals, cyanides, and powdered metals. Ensure secondary containment is used. Do not store directly on wooden shelves.

Engineering Controls

If your protocol does not permit the handling of these materials in a fume hood, assess the volatility of the material (e.g. hydrochloric acid) and contact EH&S if alternative ventilation options are necessary.
An eye wash/safety shower unit *must* be within a 10 second walk (about 35 feet) from where corrosives are being handled, with only a single intervening door, opening in the direction of travel.

Special Handling Considerations

When forming solutions/dilutions, to avoid serious splatter risk **add the corrosive to water, and never the reverse.**

Waste Management

Nitric acid waste must be segregated from organic or reducing agent waste. Best practice is to store nitric acid containing waste streams in dedicated containers segregated from all other waste streams. Reduce in-lab storage time by selecting small (≤1L) containers that are filled and removed from the laboratory promptly.

Combination of nitric acid waste with other non-compatible waste streams is a major cause of laboratory explosions.

First Aid and Emergencies

Spill
Standard spill procedures apply
Fire
Standard firefighting measures apply.
Personnel Exposure
Standard measures apply.

Laboratory Specific Information

Prior Approval Required

- ☒ **NO**
- ☐ **YES (describe):**

Designated Area

- ☐ **Entire Laboratory Area**
- ☒ **Other (describe): MRL 1043, MRL 1050**

Experimental Conditions of Use

Temperature Range: Room Temperature

Pressure Range: 1 atm

Scale Range: > 1L Other

Relevant Details:

Standard Operating Procedure

Cryogens

Overview

Cryogens are gases that have been liquefied or solidified by extreme cooling. The three common laboratory cryogens are: dry ice (-78.5 °C), liquid nitrogen (-195.79 °C) and liquid helium (-269 °C). Tissues exposed to cryogens can freeze, causing severe frostbite. They expand greatly upon evaporation which creates two hazards: oxygen displacement (asphyxiation risk) and pressurization of sealed or poorly vented containers (explosion risk). Cryogens can embrittle plastic or rubber, and crack glass due to their extremely low temperatures. Liquid nitrogen and helium can condense liquid oxygen out of the air. This powerful oxidizer can cause powerful explosions upon contact with organic materials. For carbon dioxide, the Cal/OSHA Permissible Exposure Limit (PEL: 8 hour time weighted average) = 5,000 ppm, and the Short Term Exposure Limit (STEL: 15 minute time weighted average) = 30,000 ppm.

Special Handling and Storage Concerns

Personal Protective Equipment

- Traditional white lab coat.
- Insulated, impermeable elbow-length cryogenic gloves
- ANSI Z87.1-compliant safety glasses. Safety goggles and face shield if a large splash hazard is present.

Special Storage Requirements

Cryogens should be stored in well-ventilated rooms. Due to their low pressure and protective rings around the valves and regulators, cryogen dewars do not need to be affixed to a permanent structure. Inspect pressure release devices regularly, as ice buildup can plug or otherwise disable them. Never store cryogens in tightly sealed containers, including refrigerators and freezers.

Engineering Controls

Oxygen sensors: May be necessary in rooms where large quantities of cryogens are stored or handled, or in areas with limited ventilation (closets, cold rooms).

Special Handling Considerations

Be cautious when handling cryogens in poorly ventilated areas such as cold rooms.
Avoid condensing liquid oxygen when using liquid nitrogen or helium. Check vacuum systems and other equipment for leaks, and be vigilant in checking for the presence of liquid oxygen, a blueish liquid.
When transporting cryogens on elevators, use service or freight elevators when available. In addition, when transporting cryogens by elevator:

- Post a sign reading “DO NOT ENTER – GAS TRANSPORT” to exclude passengers. Send the elevator to the desired floor, but do not enter the elevator yourself.
- When possible, have someone send the elevator up while another person waits on the receiving floor to take the cylinder out of the elevator. If this is not possible, another plan should be devised to ensure that the cylinder is taken out of the elevator once it reaches the desired floor.

First Aid and Emergencies

Uncontrolled Release

In the event of an uncontrolled release, assume that an oxygen deficient atmosphere is present. Notify others in the area and evacuate the room until adequate oxygen levels can be confirmed.

Personnel Exposure

Move person to fresh air only if safe to do so. *If you suspect that a person has lost consciousness due to oxygen deprivation, call 911 and do not enter the room*. If symptoms persist, seek medical attention.
If any tissues appear to have frozen, get medical attention immediately. Apply a dry, sterile bandage. Do not rub the affected area.

Laboratory Specific Information

Prior Approval Required

- ☒ **NO**
- ☐ **YES (describe):**

Designated Area

- ☐ **Entire Laboratory Area**
- ☒ **Other (describe): MRL 1051, MRL 1052**

Experimental Conditions of Use

Temperature Range: Room Temperature

Pressure Range: 22psi

Scale Range:

Other Relevant Details:

Standard Operating Procedure

Compressed Gases

Overview

Chemicals in this category present hazards based on one or more of these characteristics:

- Pressurization
- Oxidizing ability
- Flammability*
- High Toxicity*

Many compressed gases are also considered to be simple asphyxiants due to their ability to displace oxygen in the event of a rapid release.

***Highly toxic and pyrophoric gases are some of the most dangerous materials found in the laboratory. A gas-specific Standard Operating Procedure must be developed for these materials in conjunction with the campus Chemical Hygiene Officer**.

Special Handling and Storage Concerns

Personal Protective Equipment

- Traditional white lab coat.
- Nitrile or neoprene gloves are adequate for possible incidental exposure.
- ANSI Z87.1-compliant safety glasses.

Special Storage Requirements

Proper mounting of gas cylinders is imperative. Follow all mounting requirements as described in the UC Santa Barbara Chemical Hygiene Plan Chapter 3, section 'Chemical Inventory, Storage and Transport'.
Corrosive gases: Store lecture bottles 6 months or less, cylinders 2 years or less.
Oxidizing gases: Store with 20 feet separation from, or non-combustible partition between, *flammable gases*.

Engineering Controls

Oxygen sensors: May be necessary in rooms where large quantities of compressed gases are stored or handled, or in areas with limited ventilation (closets, cold rooms).
Carbon monoxide sensors: Required for carbon monoxide use if the cylinder or any plumbing are outside of a fume hood or gas cabinet.

Special Handling Considerations

Be cautious when handling compressed gases in poorly ventilated areas such as cold rooms.
Inspect cylinders and valves for corrosion or other damage on a regular basis.
Transport:

- Disconnect regulators and other apparatus prior to transport.
- Always replace the valve safety cap before transporting cylinders.
- Cylinders must always be transported using a hand truck or cart designed for that purpose.
- Transport cylinders upright.

When transporting compressed gases on elevators, use service or freight elevators when available. In addition, when transporting compressed gases by elevator:

- Post a sign reading "DO NOT ENTER – GAS TRANSPORT" to exclude passengers. Send the elevator to the desired floor, but do not enter the elevator yourself.
- When possible, have someone send the elevator up while another person waits on the receiving floor to take the cylinder out of the elevator. If this is not possible, another plan should be devised to ensure that the cylinder is taken out of the elevator once it reaches the desired floor.

First Aid and Emergencies

Uncontrolled Release

In the event of an uncontrolled release, assume that an oxygen deficient atmosphere is present. Notify others in the area and evacuate the room until adequate oxygen levels can be confirmed.

Personnel Exposure

Move person to fresh air only if safe to do so. *If you suspect that a person has lost consciousness due to oxygen deprivation, call 911 and do not enter the room*. If symptoms persist, seek medical attention.

Laboratory Specific Information

Prior Approval Required

☐ **NO**

☒ **YES (describe): Proper training on handling required**

Designated Area

☒ **Entire Laboratory Area**

☐ **Other (describe):**

Experimental Conditions of Use

Temperature Range: Room Temperature

Pressure Range:

Scale Range:

Other Relevant Details:

Standard Operating Procedure

Vacuum Systems

Overview

Systems under vacuum and their associated equipment have a variety of hazards associated with them, including:

- Implosion and the associated flying debris, splattering chemicals and possibly fire.
- Condensation of liquid oxygen into a cold trap using liquid nitrogen as coolant. Liquid oxygen is an explosion hazard when warmed in a closed system, and when it comes in contact with organic material.
- Pinching extremities or catching clothing in the vacuum pump belt system.
- Exposure to hazardous material due to improper venting of pump exhaust.

These systems are typically quite complicated and require extensive hands-on training prior to use.
Related SOP:

- Cryogens

Special Handling and Storage Concerns

Personal Protective Equipment

ANSI Z87.1-compliant safety glasses or goggles. A face shield is recommended if the system is made of glass or other breakable material, and is not behind a fume hood sash or blast shield.

Engineering Controls

Special Handling Considerations

General Concerns

- Understand the type of vacuum pump being used, and ensure that it is appropriate for the application (e.g. evaporation of solvents vs. high vacuum).
- Prepare for power outages. Some valves close upon loss of power, some open. Understand the effects that a series of valve openings and closings will have upon the system's integrity.
- Always replace the pump belt guard to prevent catching fingers or clothing in the mechanism.
- Glass vessels that are evacuated should be round-bottomed and/or thick-walled and designed for low-pressure work. They should be regularly checked for star cracks and scratches.

Traps and Venting

- Mechanical vacuum pumps should be protected by cold traps – generally liquid nitrogen based. Cold traps are dangerous due to their ability to condense liquid oxygen. Therefore, operation of low these traps must be thoroughly understood. Both the cooling and warming phases deserve undivided attention, and the system tested for leaks regularly.
- If hazardous materials are used with the vacuum system they should be located in, and **vented** to, a fume hood.
- Dewar flasks are insulated by being under high vacuum and are therefore subject to implosion. They should be wrapped in tape or plastic sheathing and generally come that way.

Turning ON a High Vacuum System:

- Make sure all valves are closed.
- Turn on vacuum pump.
- Place Dewar around trap flask
- Submerge trap flask in liquid nitrogen. Make sure system is under vacuum before cooling trap to avoid condensation of liquid oxygen.

Turning OFF a High Vacuum System

- Remove all samples and experiments from vacuum line.
- Remove trap flask from Dewar. Allow to warm to room temperature
- Open vacuum system to atmosphere. Do not do this while trap is cold to avoid condensation of liquid oxygen.
- Turn off pump.

Chemical Hazards

- Mechanical pump oil can become contaminated with hazardous materials. During maintenance, proper protective equipment must be employed. A ventilated area should be used for changing pump oil, as harmful vapors may be released. Clean or contaminated pump oil must be disposed of as hazardous waste via EH&S.
- Mechanical pump exhaust may require suitable scrubbing for volatile highly toxic materials. This may involve a relatively simple filter or liquid bubbler.

Waste Management

Standard waste disposal procedures apply.

First Aid and Emergencies

Spill

Standard spill procedures apply.

Fire

Standard firefighting measures apply.

Personnel Exposure

Standard measures apply.

Laboratory Specific Information

Prior Approval Required

- ☐ **NO**
- ☒ **YES (describe): Training required by certified user**

Designated Area

- ☒ **Entire Laboratory Area**
- ☐ **Other (describe):**

Experimental Conditions of Use

MRL Polymer Characterization Facility

Temperature Range:

Pressure Range:

Scale Range:

Other Relevant Details:

Standard Operating Procedure

High-Pressure Reaction Vessels

Overview

Failure/explosion of a high-pressure reaction vessel creates a significant and immediate threat from flying debris and reaction constituents. Failure can be caused by a variety of factors including:

- Overloading
- Exceeding temperature/pressure rating
- Reagents incompatible with vessel material

Special Handling and Storage Concerns

Personal Protective Equipment

- Lab Coat, flame resistant if using flammable materials. Also, a chemical resistant apron if using corrosive materials.
- Nitrile or Neoprene Gloves are adequate for possible incidental chemical exposure. Consult a glove chart if extremely toxic or corrosive material is being handled.
- ANSI Z87.1-compliant safety goggles. Goggles and a face shield when performing manipulations while to vessel is at elevated pressure.

Special Storage Requirements

Keep a log of usage for each vessel. Information on the log should include temperature, pressure, reagents/solvents used, and any inspections and tests it has undergone.

Engineering Controls

Fume Hood: If your protocol does not permit the handling of these materials in a fume hood, EH&S *must* be contacted to assess alternate ventilation options.

Blast Shield: A portable blast shield should be used for small vessels being operated in a fume hood. Custom barricades/shields should be designed for vessels that are not operated inside a fume hood. These barricades/shields should protect in all directions that debris or reaction mixtures could fly in the event of a vessel failure.

Special Handling Considerations

Perform high-pressure operations only in special chambers equipped for this purpose. Commercially available high pressure reactor vessels are designed and manufactured to ensure safe operation when used within the temperature and pressure limits for which they are rated. **Any documentation and manuals that pertain to the reactor vessel in use must be thoroughly read, understood and consulted regularly.** However, in the end it is the user's responsibility to make sure that the selected vessel is compatible with the reagents and conditions to which it will be exposed during the experiment.

To this end, the user must:

- Select a vessel which has the capacity, pressure rating, corrosion resistance and design features that are suitable for its intended use.
- Operate the vessel within a suitable barricade/shield, if required.
- Establish training procedures to ensure that any person handling the equipment knows how to use it properly.

- Maintain the equipment in good condition, and test periodically per the vendor's instructions to ensure that the vessel is remains structurally sound.
- Complete a hazard assessment before initiating the experiment, including:
    - Assessment of any intermediates, side-products and products that may form and their behavior within the vessel, including their corrosive nature and their tendency to violently decompose at elevated temperature and pressure.
    - Determination of maximum temperature and pressure limits expected, taking into account the energetics of the reaction being conducted and any pathways that might cause the reaction to run out of control.
- Maintain adequate ventilation. This can be achieved by installing the reactor within a fume hood, attaching tubing to the rupture disk that extends to an appropriate exhaust such as the interior of a fume hood, or by ensuring that the lab area as a whole has adequate ventilation and that the reactor is installed near an exhaust fan (in the case of larger reactors).
- Run preliminary experiments using small quantities of reactants when starting work with new or unfamiliar materials.
- Use appropriate PPE, including safety glasses, chemical resistant gloves, a lab coat, and also a face shield for operations that present particular hazards.
- Keep a log of usage for each vessel. Information on the log should include temperature, pressure, reagents/solvents used, and any inspections and tests it has undergone.

Particular Hazards of Note

Potentially Explosive Material

There are a number of functional group categories whose presence within a structure is a common indication of explosive potential. Use of reagents containing these functional groups in a high-pressure reactor is contraindicated. These include but are not limited to: peroxides, perchlorates, azides, metal acetylides, etc.

Loading Limits

Overloading of a pressure vessel is a significant hazard. Dangerous pressures can develop suddenly and unexpectedly when a liquid is heated in a closed vessel if adequate head-space is not available to accommodate the expansion of the liquid. *This is particularly true of water and aqueous solutions, whose volume may increase up to a factor of three when heated to 374 ^{o}C.*

A vessel must **never** be filled to more than three-fourths of its available free space. Frequently, the maximum fill level must be reduced even more to insure safe operation. If a table of volume multipliers[1,2] is available for the solvent in use, use this data to calculate to maximum allowable loading using the formula:

Max. Loading Volume = (0.9)(Vessel Volume)/Volume Multiplier at Max. Temp.

Limitations of the Material of Construction

[1] **"Steam Tables : Thermodynamic Properties of Water Including Vapor, Liquid, and Solid Phases/With Charts"** Joseph H. Keenan, Frederick G. Keyes, Philip G. Hill , Joan G. Moore, Krieger Pub Co, 1992.
[2] Parr Instrument Company document No. 230M: **"Safety in the Operation of Laboratory Reactors and Pressure Vessels"**

Pressure vessels of identical design but of differing materials of construction will have vastly different pressure and temperature limits, as well as differing corrosion resistance towards solvents and reagents (acids and bases in particular). The material of construction of the vessel must be known and its limitations understood before initiating an experiment. For commercial reactor vessels, the user's manual and other documentation is an excellent resource for this information.[2]

Decontamination
Standard measures apply

Laboratory Specific Information

Waste Management

First Aid and Emergencies

Spill
Standard spill procedures apply
Fire
Standard firefighting measures apply.
Personnel Exposure
Standard measures apply.

Prior Approval Required

- ☐ **NO**
- ☒ **YES (describe): Proper training by certified user required**

Designated Area

- ☒ **Entire Laboratory Area**
- ☐ **Other (describe):**

Experimental Conditions of Use

Temperature Range:

Pressure Range:

Scale Range:

Other Relevant Details:

Standard Operating Procedure

Ethylene Oxide





Overview

Ethylene oxide, or oxirane, is an **extremely flammable** gas at room temperature. Dissolved in water, it remains flammable at a concentration of 4% by volume, making it a serious explosion hazard if poured down the drain.

Ethylene oxide can **self-polymerize violently upon exposure to heat, acid, or base**. Violent reaction can occur with exposure to copper or its alloys, and rust. The heat of burning in a fire may cause the additional hazard of self-polymerization, resulting in explosion.

Ethylene oxide is classified as **Category 1B carcinogen**.

Ethylene oxide is **acutely toxic if inhaled**, causing a variety of symptoms up to and including *headaches, nausea, edema of the lungs, paralysis, convulsions and death*. Its odor threshold is > 200 ppm, while its permissible exposure limit is 1 ppm, therefore the sense of smell does not provide adequate protection against its toxic effects.

Ethylene oxide is **corrosive to tissue**. Symptoms may be delayed. Skin sensitization may also occur. Contact with liquid ethylene oxide can cause severe frostbite.

Special Handling and Storage Concerns

Personal Protective Equipment

- Flame Resistant Lab Coat
- Butyl rubber, Teflon or Silvershield gloves are recommended.
- ANSI Z87.1-compliant safety glasses for very small quantities. Safety goggles/face shield if any splash hazard is present.
- OSHA recommends against contact lens use when working with ethylene oxide.

Special Storage Requirements

Store at 2-8 °C. Incompatible with acids, alkaline salts, copper and rust.

Engineering Controls

All laboratory use must occur inside of a fume hood. This includes the container any plumbing being used to deliver the ethylene oxide into the reaction vessel.

Special Handling Considerations

This material has poor warning properties, as its odor threshold is more than 200 times higher than the permissible exposure limit. Great care must be taken to ensure that there is no leakage of the material into the laboratory.

Explosion-proof equipment and proper grounding and bonding should be used.

Keep away from flame.

Decontamination

Standard decontamination procedures apply. Use great caution in avoiding exposure.

Waste Management

Standard waste disposal procedures apply. Great care must be taken to ensure that any unreacted material is not released into the laboratory.

First Aid and Emergencies

Spill

Treat all spills of benzene as major spills. Do not attempt to clean up the spill yourself. Notify others in the area of the spill, including your supervisor. Evacuate the area and call 911. Remain on-site at a safe distance to provide detailed response to first responders. Report any exposures to EH&S.

Fire

Standard firefighting measures apply.

Personnel Exposure

Skin or eye contact: Remove contaminated attire. Flush affected area with water for 15 minutes. Get medical attention immediately.

Inhalation: Move person to fresh air. Get medical attention immediately.

Ingestion: DO NOT induce vomiting. Rinse mouth with water. Get medical attention immediately.

Laboratory Specific Information

Prior Approval Required

☐ **NO**

☒ **YES (describe): Proper training by certified user required (Please contact Segalman or Hawker groups for further training).**

Designated Area

☐ **Entire Laboratory Area**

☒ **Other (describe): MRL 1043**

Experimental Conditions of Use

Temperature Range:

Pressure Range:

Scale Range:

Other Relevant Details:

Standard Operating Procedure

Sharps Safety

Waste Management and Labeling

Overview

Sharps are sharp objects–e.g., needles, syringes with needles, scalpels, blades, disposable scissors, suture equipment, stylets, and trocars, broken test tubes, and glass that could be contaminated with biological samples, chemicals, radioactive materials or non-contaminated. This document summarizes proper collection, labeling and waste management of sharps

I. Sharps Contaminated with Biohazardous or Medical Waste:

Storage Requirements and Labeling:

Collect in a biohazardous sharps container that is red, rigid, puncture resistant and leak proof.

Waste Management:

Option 1:

Treat the sharps container for a minimum of 30 minutes at 121°C in an autoclave permitted for the treatment of medical waste and label it as "autoclaved."

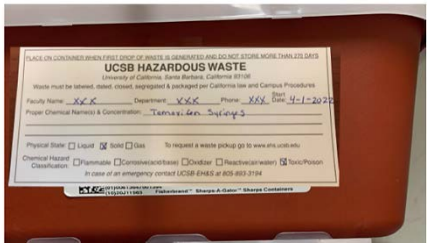
Submit an online Chemical Waste Collection Request via the EH&S website. Note on the request that the material has been autoclaved. *Alternatively*, leave the autoclaved sharps container at Bio II 4106, LSB 2204 or LSB 4218, where it will be picked up without a request.

Option 2:

Request pick-up of un-autoclaved sharps containers by the BNL Autoclave Core, which will autoclave and arrange for disposal for a fee: https://www.cnsi.ucsb.edu/resources/facilities/autoclave-core

Groups generating large quantities of biohazardous sharps waste must contract with a certified medical waste management company for pick-up and disposal.

II. Sharps Contaminated with Hazardous Chemicals:



Storage Requirements and Labeling:

Cover any biohazard labels with a hazardous waste label and list the chemical constituents. Complete ALL sections of the label. Add the Month/Day/Year at which the sharps waste was first stored.

Waste Management:

Once the sharps container is full or is 9 months old (whichever occurs first), submit an online Chemical Waste Collection Request via the EH&S website.

III. Sharps Contaminated with Radioactive Material:

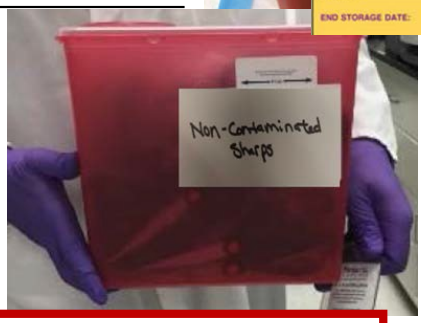
Storage Requirements and Labeling:

Cover any biohazard labels with a radioactive waste label and include the radioactive isotope.

Waste Management:

Submit an online **Radioactive** Waste Collection Request via the EH&S website.

IV. Non-Contaminated Sharps



Storage Requirements and Labeling:

Cover any biohazard labels with a **PLAIN** label as shown on the picture.

Write "Non-Chemical/Non-Medical Sharps" or "Non-Contaminated Sharps" on the label.

Do Not Use Hazardous Waste Labels for Non-Contaminated Sharps Collection!

Waste Management:

When the container is full, submit an online Chemical Waste Collection Request via the EH&S website.

V. Broken Laboratory Glass

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, chemicals or radioactive materials 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 disposal procedures given above.)

Storage Requirements and Disposal:

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 carts.)*
2. Place unwanted or broken 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 and re-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.

Cardboard Lab Glass Boxes
(and autoclaved Waste Bags)

Carts served by MarBorg on Saturdays
Questions: Matt O'Carroll

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First Aid and Personnel Exposure

- Clean the affected area. Wash needle sticks and cuts with soap and water. The laboratory sink, emergency shower and eye wash stations will be used as necessary to flush affected areas with water for several minutes.
- Report the incident. Exposures must be reported to the PI or Lab Safety Contact immediately. **Staff exposures** or injuries are recorded with an Employer's First Report: https://www.ehs.ucsb.edu/workcomp

Student exposures or injuries are filed via this webpage:
https://www.ehs.ucsb.edu/riskmanagement/incident-reporting

- Seek treatment. Healthcare personnel treating exposed patients must be informed of the hazardous materials involved in the exposure.

Employees and personnel on University pay status seek treatment:
During work hours: Sansum Occupational Medicine Center, 101 South Patterson Avenue, Santa Barbara, CA 93111, and
after business hours: Sansum Urgent Care Center, 215 Pesetas Lane, Santa Barbara, CA 93110.
Students are to seek treatment
During work hours: UCSB Student Health Services, Building 588, at El Colegio and Ocean Road, Santa Barbara CA 93117, and
after business hours at Goleta Valley Cottage Hospital, 351 S. Patterson Avenue, Goleta CA 93117.

Section II: UC & UCSB policies, procedures and resources

Contents

CHEMICAL HYGIENE PLAN 1
Chapter 1: Introduction 2
Scope of this document 2
Rights and Responsibilities 3
Other UC Santa Barbara Safety Programs 7
Chapter 2: Training and Outreach Programs 9
On-Boarding Requirements for New Researchers 9
The Laboratory Safety Review Program 10
Incentive Programs and Targeted Trainings 11
Chapter 3: Handling Hazardous Chemicals 13
Chemical Hazard Classes 13
Chemical Hazard Communication 24
How to Reduce Exposures to Hazardous Chemicals (Hazard Controls) 27
Good Laboratory Practices 38
Chemical Inventory, Storage, and Transport 41
Chemical Exposures: Limits, Assessments, and Medical Evaluations 50
Hazardous Chemical Waste Management 55
Chapter 4: Emergencies 62
Accidents 63
Laboratory Safety Equipment 64
Fire-Related Emergencies 66
Chemical Spills 66
Earthquake 69
Chapter 5: Compliance 70
Recordkeeping Requirements 70
Notification and Accountability 70
Compliance Procedures 70
Acknowledgements 73

Chapter 1: Introduction

Scope of this document

UC Santa Barbara is committed to providing a healthy and safe working environment for the campus community. In the case of laboratory personnel, a formal safety program is outlined in the form of the Chemical Hygiene Plan, as required by Cal/OSHA regulation 8 CCR §5191, also known as the *'Laboratory Standard'*. This document describes the training and controls in place to protect laboratory personnel against adverse health and safety hazards associated with exposure to potentially hazardous chemicals. This includes all proper use and handling practices and procedures to be followed by faculty, staff, students, visiting scholars, volunteers, and all other personnel working with potentially hazardous chemicals in a laboratory setting.

To be defined as a laboratory setting, the following criteria must be met:

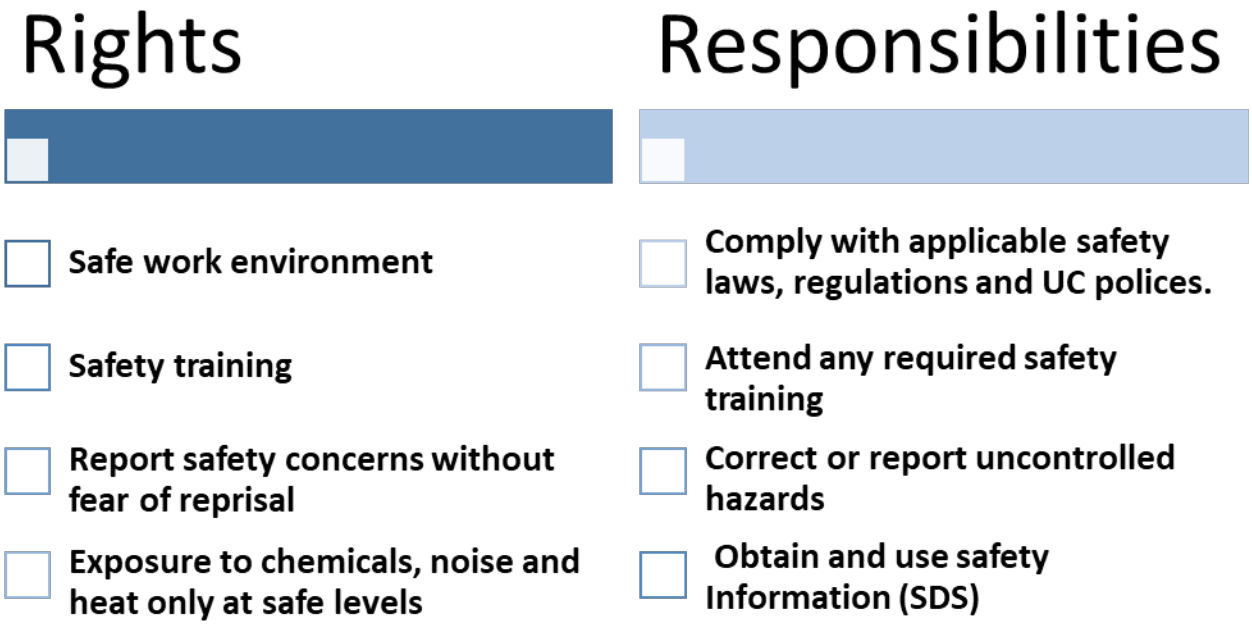
- Chemical manipulations are on a scale that is easily and safely manipulated by one person (lab scale).
- Multiple chemical procedures are used.
- Procedures are not part of a production process, nor simulate a production process.
- Protective laboratory practices and equipment are available and commonly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

The information presented in this document represents best practices and provides a broad overview of the information necessary for the safe operation of laboratories that utilize potentially hazardous chemicals. It is not intended to be all inclusive, nor should it be considered a complete Chemical Hygiene Plan. To be considered a complete Chemical Hygiene Plan, this document must be accompanied by a set of Standard Operating Procedures developed by researchers and approved by the Principal Investigator/Laboratory supervisor. Templates for the development of these SOP's are available from Environmental Health and Safety.

The CHP does not apply to research involving *exclusively* radiological or biological materials, as these safety procedures and regulatory requirements are outlined separately in the Radiation Safety Manual and the Biosafety Guide respectively. Research that involves more than one type of hazard must comply with all applicable regulatory requirements and follow guidance outlined in the relevant safety manuals.

Areas that are defined as laboratories by the university, but that use no chemicals or only a limited amount of specific low-hazard chemicals, may be exempt from the requirement to have a Chemical Hygiene Plan. Upon receiving this exemption, these laboratories will be required instead to comply with the Injury and Illness Protection Program or the Hazard Communication Standard, respectively. Any PI/Laboratory Supervisor wishing to investigate this possibility should contact EH&S for a hazard assessment.

Rights and Responsibilities



Responsibilities of All Personnel who handle Potentially Hazardous Chemicals

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

1. Completing all required trainings and refreshers. Ensuring that this training has been documented on a Training Needs Assessment form.

2. Reviewing, understanding and following the Chemical Hygiene Plan and all other appropriate Safety Manuals and Policies as determined by the hazards present in the laboratory.

3. Following all verbal and written rules, Standard Operating Procedures and policies established by the PI/Laboratory Supervisor.

4. Developing good personal chemical hygiene habits, including keeping the work area safe and uncluttered, ensuring that fume hoods are not used for storage, etc.

5. Immediately reporting unsafe acts, unsafe conditions and lab accidents to the PI/Laboratory Supervisor, and being prepared for laboratory accidents and emergencies (knowing emergency response procedures).

6. Assessing and controlling hazards associated with their experiments and work area prior to conducting work, including consistent and proper use of Engineering Controls (e.g. fume hoods),

Administrative Controls (e.g. SOP's), and Personal Protective Equipment (e.g. safety glasses and lab coats).

7. Following all UC Santa Barbara, state and federal requirements for the collection and disposal of hazardous waste.

8. When working autonomously or performing independent research work:
    a. Reviewing the plan or scope of work for their proposed research with the PI/Laboratory Supervisor.
    b. Notifying in writing and consulting with the PI/Laboratory Supervisor, in advance, if they intend to significantly deviate from previously reviewed procedures. Examples of significant changes include change in objectives, change in experimental conditions, change in required PPE, and reduction or elimination of administrative and/or engineering controls.
    c. Preparing SOPs and hazard analyses and performing literature searches relevant to safety and health that are appropriate for their work, and
    d. Providing appropriate oversight, training and safety information to personnel they supervise.

9. Disposing of, or transferring to new ownership, all research materials in advance of leaving their assigned laboratory space (e.g. leaving the research group, leaving UCSB, relocating to new space).

Responsibilities of the Principal Investigator/Laboratory Supervisor

The Principle Investigator or person responsible for the laboratory space has the responsibility for the health and safety of all personnel working in his or her laboratory who handle hazardous chemicals. *The tasks and duties related to this may be delegated, but the responsibility for ensuring that these duties are adequately performed remains with the PI/Laboratory supervisor*. The PI/laboratory supervisor is responsible for:

1. Training all laboratory personnel to work safely with hazardous materials. This includes ensuring that they attend any mandatory trainings, review the hazard assessment, read and sign the group Chemical Hygiene Plan, and document this training on the Training Needs Assessment form.

2. Completing a hazard assessment for their laboratory using the online ASSESSMENT tool as well as recertifying the assessment every three years, ensuring the lab roster is up to date and that all lab members have acknowledged the hazard assessment and completed PPE training. Completing all required Standard Operating Procedures as determined by the contents of their chemical inventory. Implementing the necessary controls as guided by this process. Ensuring that lab personnel notify the PI in writing in advance of deviating significantly from these published procedures and assessments. Examples of significant changes include change in objectives, change in experimental conditions, change in required PPE, and reduction or elimination of administrative and/or engineering controls

3. Providing laboratory workers continuous access to the Chemical Hygiene Plan, either hard copy or electronic, and ensuring that the group-specific materials (contact information, standard operating procedures, etc.) are current and updated annually.

4. Knowing all applicable health and safety rules and regulations, training and reporting requirements associated with chemical safety for regulated substances (Controlled Substances, Regulated Carcinogens, Select Agents (toxins), Homeland Security Chemical Facility Anti-Terrorism Standard chemicals of interest, etc.)

5. Monitoring the safety performance of laboratory workers and visitors, and enforcing policies and rules.

6. Promptly disposing of used, excess or unwanted hazardous chemicals following UC Santa Barbara, state and federal waste disposal requirements.

7. Addressing any findings arising from the Laboratory Safety Review process in the time allotted for the priority level of the finding.

8. Promptly reporting all accidents, injuries and fire extinguisher use to EH&S. For injuries, also completing all worker's compensation reporting requirements.

9. Informing facilities personnel and outside contractors of potential workplace-related hazards when they are required to work in the laboratory space. This includes identifying and removing potential hazards to provide a safe environment for repairs and renovations.

10. Assigning one or more responsible persons the requirements listed above if the PI/Laboratory Supervisor will be on extended leave (> 2 weeks).

Responsibilities of Environmental Health and Safety

EH&S is responsible for administering and overseeing institutional implementation of the Laboratory Safety Program. The Chemical Hygiene Officer (CHO) has primary responsibility for ensuring the implementation of all components of the CHP. The Fire Marshal is responsible for plan review, construction inspections, fire clearance, fire prevention inspections, testing and consultative services related to fire prevention. In case of life safety matters or immediate danger to life or health (IDLH), the Director of EH&S or designee has the authority to order immediate cessation of the activity until the hazardous condition is abated. EH&S provides technical guidance to personnel at all levels of responsibility on matters pertaining to laboratory use of hazardous materials.

The CHO is responsible for:

1. Informing PI/Laboratory Supervisors of all health and safety requirements and assisting with the selection of appropriate safety controls, including appropriate laboratory practices, personal protective equipment and engineering controls for the scope of work being conducted.

2. Managing the Laboratory Review Program. Consulting with the EH&S laboratory safety specialists on the results of their reviews, and necessary steps to abate hazards that may pose a risk to life or safety upon their discovery.

3. Assisting PI/Laboratory Supervisors with hazard assessments, upon request.

4. Assisting the PI/Laboratory Supervisors with the development of SOPs, upon request.

5. Helping to develop and implement appropriate chemical hygiene policies and practices.

6. Having working knowledge of current health and safety rules and regulations, training, reporting requirements, and standard operating procedures associated with regulated substances.

7. Providing technical guidance and investigation for laboratory accidents, injuries and near misses.

8. Reviewing and evaluating the effectiveness of the campus-wide portions of the CHP at least annually and updating it as appropriate.

9. Providing consultation to the Chemical and Laboratory Safety Committee in the development and implementation of appropriate chemical hygiene policies and practices, and the development of SOPs and SOP templates.

The Chemical Hygiene Officer for the departments of: Chemistry & Biochemistry, Materials, Chemical Engineering and Electrical and Computer Engineering is Nikolai Evdokimov (nevdokimov@ucsb.edu)

The Chemical Hygiene Officer for all other departments is Hector Acuna (hector.acuna@ucsb.edu).

The Fire Marshal is responsible for:

1. Ensuring that the campus complies with California statutes, and fire and life safety rules and regulations of the California State Fire Marshal as adopted or referenced in Title 19 and Title 24 (Parts 2m3m4m5 and 8) of the California Code of Regulations.

2. Inspecting campus facilities, processes and fire protection systems to ensure conformance with State statutes, rules, regulations, and UC fire safety policy.

3. Providing training in fire prevention and use of fire extinguishers.

The Campus Fire Marshal is James White (james.white@ucsb.edu).

Responsibilities of the Chemical and Physical Hazard Safety Committee

The Chemical and Physical Hazards Safety Committee is empowered to promote a safe working environment with respect to chemical and physical hazards in all research and teaching laboratories on campus. It would advise and report to the Chancellor through the Vice Chancellor of Research. The physical hazards covered by this committee include all such hazards not covered by another safety committee, e.g. radioactive materials. These hazards include but are not limited to: electrical hazards, magnetic fields, lasers, extreme temperatures, pressure and vacuum, kinetic energy and noise.

The Chemical and Physical Hazard Safety Committee is responsible for:

Immediate/Emergency functions:

1. Convene with urgency upon the occurrence of an incident or near-miss in order to analyze the situation and advise on immediate actions necessary to mitigate the risk until long-term corrections are in place.

2. Execute formal escalation protocols to address cases of known but uncorrected noncompliance with Federal/State/local safety regulations as well as UC and UCSB safety related policies.

Administrative functions

1. To review, edit and approve annual updates to the campus Chemical Hygiene Plan (CHP) generated by the Research Safety Division of EH&S

2. Develop, recommend, update and maintain policies and procedures applicable to chemical and physical hazard safety. To enable this process, the committee will:
    a. Receive and review summary reports from EH&S laboratory safety inspections, near miss reports and incident reports.
    b. Review findings of inspectors from outside agencies including state and federal regulatory authorities.
    c. Receive input from individual faculty and researchers.

3. Establish formal escalation protocols to address cases of known but uncorrected noncompliance with Federal/State/local safety regulations as well as UC and UCSB safety related policies.

4. Establish and review strategies to ensure adequate surveillance, hazard identification and risk assessment of laboratory activities related to chemical and physical hazards.

5. Design review of new and renovated laboratory space.

Responsibilities of Campus Administration

The Chancellor and Vice Chancellors are responsible for the implementation of UC Santa Barbara's Environmental Health and Safety Policy on campus property. Deans, Directors, and Department Chairs are responsible for establishing and maintaining safety programs in their area to ensure they are providing a safe and healthy work environment.

Other UC Santa Barbara Safety Programs

Given the breadth of research at UCSB, there are other campus safety programs and regulations that can apply to a given operation. Affected individuals should contact these program managers for further information:

Injury and Illness Prevention Program: The "umbrella" OSHA-required worker safety program that applies to all campus workers, regardless of work activities. There is significant overlap between IIPP elements and this manual as relates to lab work, particularly the training and inspection components.

Biological Safety Program: Biological Use Authorizations; Aerosol Transmittable Diseases; Blood borne Pathogens; Medical Waste Management

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

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

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

Field Research Safety: Training and resources for research field work.

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

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

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

Respiratory Protection Program: Per Cal/OSHA regulations and UCSB Campus Policy, all UCSB personnel who use respiratory protection equipment including filtering facepiece respirators (dust masks) shall be included in the UCSB Respiratory Protection Program.

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

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

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

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

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

Chapter 2: Training and Outreach Programs

On-Boarding Requirements for New Researchers

Effective training is critical to facilitating a safe and healthy work environment and preventing laboratory accidents. All PI/Laboratory Supervisors must participate in formal safety training and ensure that all their employees have appropriate safety training before working in a laboratory, per UC policy. At UC Santa Barbara, these new researcher training requirements are satisfied by completing the following:

Fundamentals of Laboratory Safety

This is the initial training course that is required before entry into the laboratory is allowed. It can be taken live or online. Live classes are offered in the fall for all incoming graduate students, and every two months year-round. The online class is accessed through the UC Santa Barbara Learning Center. Instructions on how to activate your NetID and register for the class are found here. This course covers the following:

- Review of laboratory rules and regulations, including the Chemical Hygiene Plan.
- Recognition of laboratory hazards.
- Types of engineering controls and personal protective equipment.
- Signs and symptoms associated with exposures to hazardous chemicals.
- Chemical exposure monitoring.
- Procedures for disposing of chemical waste.
- Fire safety and emergency procedures.

The primary difference in content between the live and online class is that the live class includes hands-on fire extinguisher training. Otherwise, the two classes are considered equivalent by EH&S. PI/Laboratory Supervisors and/or departments may however choose to require the live class over the online class. Whichever class is taken, there is an online refresher course required every three years. Those due for the refresher class will get an automated email from the Learning Center.

Laboratory Specific Hazard Assessment Review (ASSESSMENT Online Tool)

Identifying hazards in the workplace is the fundamental first step in developing the appropriate controls for a safe workplace. Conversely, it is impossible to protect oneself from risks in the workplace if the hazards present have not been fully identified and understood.

At UC Santa Barbara, the online tool for identifying hazards in the laboratory is called ASSESSMENT. This tool allows the PI/Laboratory Supervisor to:

- Assign members to a lab group.
- Determine hazards that are present in the lab through a set of guided questions.
- Easily communicate laboratory hazards to group members.
- Identify the proper personal protective equipment (PPE) to be used.

It allows group members to:

- View potential hazards present in the laboratory.

- Receive a list of proper PPE to be used in their lab setting, and a voucher for obtaining the PPE for free.
- Receive training on that PPE.

The PPE distribution center at UC Santa Barbara is located in the Chemistry building storeroom/receiving area (building 557, room 1432). The full process for obtaining PPE is outlined here.

Laboratory-Specific Safety Orientation

All new researchers must receive a day-one laboratory safety orientation per UC policy. This orientation includes emergency procedures and location of emergency equipment, Injury and incident reporting procedures, engineering control use (fume hoods, etc.), a review of the Chemical Hygiene Plan and group specific SOP's, physical hazard training (e.g. cryogens, high voltage, etc.) PPE use and waste disposal procedures. These lab-specific trainings should be conducted by the PI/Laboratory Supervisor or an experienced research group member who is familiar with the hazards present in the laboratory.

Additionally, any other training requirements should be assessed at this time. This includes use of radioactive materials, radiation producing machines, lasers, biological hazards, controlled substances, etc. These are formal classes that are conducted by EH&S staff.

All of the above training needs and documentation of receipt of that training must be kept on the Training Needs Assessment form. This form is in checklist format to assist the PI/Laboratory Supervisor in determining what trainings that individual needs. Generally, one form per researcher is generated and kept in the research group's files, although some shared facilities use modified but compliant approaches.

The Laboratory Safety Review Program

Environmental Health and Safety visits each lab space at least once per year. The main program through which these visits are conducted is the Laboratory Safety Review Program. This process consists of the following steps:

1. An EH&S staff member will reach out to each research group and schedule a meeting time with the PI/Laboratory Supervisor or a delegate.

2. The EH&S staff member and the PI/delegate will review various elements of the group's safety program: standard operating procedures, training records, walk-through of the physical space, etc.

3. A report will be sent to the PI/Laboratory Supervisor via an email directing them to log into our online INSPECT tool.

4. A follow-up visit will then be scheduled so that EH&S can validate and assist with the resolution of any findings.

Laboratories with Biological and/or Radiological hazards will also receive independent targeted visits from the Biosafety Officer and/or the Radiation Safety Officer.

Additionally, it is strongly recommended that employers (PI's) conduct regular self-inspections of their workspaces. To assist with this, EH&S has developed this Self-Inspection Checklist.

Incentive Programs and Targeted Trainings

Incentive Program

The Research Safety Incentive Program provides EH&S the opportunity to recognize the contribution of those laboratories or individuals that have improved the safety culture. This program has two facets, described below.

On the Spot Safety Award

We will recognize lab workers who are proactive in furthering and modeling behavior that is illustrative of a positive laboratory safety culture such as:

- Wearing proper protective equipment.
- Reporting a near miss that could have resulted in injury/illness.
- Recommending a meaningful, innovative improvement for a safer work area.

On-the-Spot Awards are presented to researchers by EH&S staff as the behavior is observed, and throughout the year. They consist of a small gift such as a gift card for a food or beverage establishment.

Laboratory Safety Recognition

We will recognize lab groups for their effort and devotion to safety. This includes those who display a strong safety culture as determined by Laboratory Safety Reviews as well as by regular informal interactions with EH&S staff.

EH&S will arrange a lunch or breakfast meeting with the lab group to recognize their efforts and allow for open discussion of any concerns, issues, or best practice ideas. We will also feature the lab group in the EHS newsletter: Safety Slick.

Targeted Training

The goal of UC Santa Barbara is to achieve more than simple regulatory compliance. This campus strives toward fostering a strong, positive safety culture by integrating safety as an essential element in the daily work of laboratory researchers. EH&S's time and attention is therefore dedicated to providing assistance and guidance to lab groups on growing and optimizing their safety practices. We will provide hands on (refresher) trainings to those groups showing a need in a specific area. For example, if a lab group has continued issues of poor hazardous waste practices (e.g. open unattended containers, missing/incomplete waste label, etc.) we will arrange for a training in the lab. *Additionally, EH&S is available to consult and meet with lab groups to discuss any relevant safety topic/issue at the researchers' request.* By meeting with lab groups and

providing trainings as needed, EH&S hopes to foster a positive atmosphere for communication, education, advice, discussions, and the sharing of progress. Please feel free to contact your department's EH&S representative if you would like us to meet your group to discuss a safety topic or to provide a training:

Nelly Traitcheva (nelly.traitcheva@ucsb.edu) for:	Chandra Feeser (chandra.feeser@ucsb.edu) for:
Anthropology	Chemistry & Biochemistry
Bren School	ECE
Chemical Engineering	Materials
CNSI	MCDB
EEMB	Mechanical Engineering
Earth Science	MRL
ERI	NRI
Geography	Physics
MSI	
NRS	
Psychological and Brain Sciences.	

Chapter 3: Handling Hazardous Chemicals

Chemical Hazard Classes

The Globally Harmonized System (GHS) of hazard communication was developed to identify to the user of a material both the hazards and the risks associated with it. This system recognizes thirty one classes of chemical hazards. These classes fall into three broad categories: physical hazards, health hazards, and environmental hazards. In addition, the severity of the hazard is assigned a numerical category of 1-4, with 1 being the most severe. These categories are rigorously defined for each hazard class in the OSHA publication Hazard Communication: Hazard Classification Guidance for Manufacturers, Importers and Employers. A material may exhibit more than one hazard. A material's hazard class(es) determine how it is stored and handled, what special equipment may be needed, and what procedures need to be established to ensure safe handling. GHS information can be found on all commercial chemical labels printed after 2015, and the Safety Data Sheet (SDS) associated with that chemical. Any release of these materials to the environment must be reported to Environmental Health & Safety Immediately. Listed below are the hazard classes, along with the associated GHS pictogram.

Reactive and Unstable Chemicals.

Reactive and unstable chemicals are those that may decompose violently, polymerize or self-react under conditions of shock, friction, temperature, pressure, light, or contact with other materials, resulting in the release of large volumes of gas or heat. Therefore, storage of these materials in such a way as to protect from these conditions is of the utmost importance. Additionally, they must be stored segregated from other materials in cabinets or refrigerator/freezer designed for storing flammable and reactive chemicals. *Examples: explosives, peroxides, azo and azido compounds.*

Oxidizers

Oxidizers are chemicals that cause or increase the intensity of the combustion of other materials. They can do so by delivering oxygen atoms, or by other means. Oxidizers should be stored in a cool, dry place and kept away from flammable and combustible materials such as organic chemicals, wood and plastic, and away from reducing agents.
Examples: Oxygen, Bromine, Nitric Acid, Hydrogen Peroxide.

Flammable Chemicals

Flammable liquids include those chemicals that have a flashpoint of less than 100 °F. These materials must be stored in flammable storage cabinets, with no more than 10 gallons/room total outside of storage (including flammable organic

waste). Flame-resistant laboratory coats must be worn when working with large volumes of flammable materials (>1L) and/or with procedures where a significant fire risk is present, such as working with an open flame or pyrophoric materials. These materials constitute a significant immediate threat and should be treated with particular care, given the comparatively large quantities that can be present in a laboratory setting. Particular attention should be given to preventing static electricity and sparks when handling flammable liquids. This can be accomplished in part by appropriately grounding metal flammable storage cabinets and any metal dispensing drums inside them, as well as the receiving container.
Examples: Diethyl Ether, Acetone, Hexane

Pyrophoric Materials are a class of materials that spontaneously ignite when in contact with air and require laboratory-specific training. Flame-resistant laboratory coats and hand protection must be worn when handling these chemicals**. Before working with pyrophoric materials, individuals must demonstrate knowledge of the appropriate methods to handle, transfer, and quench the material being used.** Templates for generating Standard Operating Procedures for pyrophoric materials handling can be found in the UC Santa Barbara SOP Template Library.
Examples: Grignard reagents, organolithium reagents, silane.

Water Reactive Chemicals can evolve flammable or toxic gas when they come into contact with water *or atmospheric moisture*. Like pyrophoric materials, this reaction may produce enough heat to ignite any flammable gases thus generated. Therefore, they should be stored away from water and other sources of protons, such as acidic materials.
Examples: potassium metal, sodium metal

Corrosives

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

- Strong acids: sulfuric, nitric, hydrochloric, etc.
- Strong bases: sodium hydroxide, potassium hydroxide, ammonium hydroxide.
- Dehydrating agents: phosphorus pentoxide, calcium oxide, etc.
- Oxidizing agents: hydrogen peroxide, chlorine, bromine, etc.

Symptoms of exposure via inhalation include a burning sensation, coughing, wheezing, laryngitis, shortness of breath, nausea and vomiting. For eye exposure, symptoms include pain, redness, tearing and blurring of vision. For exposure to the skin, symptoms may include pain, redness, inflammation, blistering and burns.

As a physical hazard, corrosive substances may degrade materials they come in contact with and may react violently. It is important to review information regarding the materials they may corrode, and their reactivity with other substances. They should be stored in chemically-compatible secondary containers, and should be segregated from other classes of materials.

Irritants and Sensitizers

Irritants are non-corrosive chemicals that cause reversible inflammatory effects on living tissue by chemical action at the site of contact. A wide variety of organic and inorganic compounds, including many chemicals that are in a powder or crystalline form, are irritants. Consequently, eye and skin contact with all laboratory chemicals should be avoided. Symptoms of exposure can include reddening or discomfort of the skin and irritation to respiratory systems.
Examples: Chlorine, methylene chloride, formaldehyde

Sensitizers are chemicals which cause a substantial proportion of exposed people or animals to develop an allergic reaction after repeated exposure to the chemical. Symptoms can include all of the symptoms normally associated with allergic reaction, including life-threatening anaphylaxis.
Examples: diazomethane, chromium, nickel, formaldehyde, isocyanates, many phenol derivatives.

Compressed Gases and Cryogenic Liquids

Compressed gas cylinders are pressurized vessels that pose both physical and health hazards additional to those of the gases they contain, and therefore must be handled and stored carefully. For example, even an inert, non-toxic gas like nitrogen poses an asphyxiation risk if the pressure in a nitrogen tank is released suddenly enough to overwhelm room ventilation. Additionally, a cylinder rupture (generally occurring at the weak spot in the cylinder located and the connection between the body of the cylinder and the valve) can lead to the cylinder becoming a projectile and endangering personnel, equipment and structures. Additionally, the gases themselves may have hazards associated with them such as flammability (hydrogen), toxicity (ammonia), reactivity (fluorine) and pyrophoricity (silane). **Highly toxic and pyrophoric gases are some of the most dangerous materials found in the laboratory. A gas-specific Standard Operating Procedure must be developed for these materials in conjunction with the campus Chemical Hygiene Officer**. *Examples of highly toxic gases: hydrogen fluoride, methyl bromide, nickel carbonyl, phosgene.*

All compressed gas cylinders must be stored with the safety cap in place when not in use. Cylinders must be held in place by a welded-link steel chain attached to mounts bolted into the structure, or chained in a cylinder storage rack. Specific gases may have additional storage requirements. Refer to the 'Compressed Gases' SOP for more information.

Cryogenic liquids such as liquid nitrogen and helium pose similar asphyxiation risks as their compressed gas counterparts. Additional hazards include frost burn of the skin and eyes. Always use appropriately insulated gloves when handling cryogenic liquids. Face shields may be needed, in addition to safety glasses/goggles, in cases where splashing may occur or when cryovials are being handled as they may explode when warmed. As cryogen dewars are at low pressure and have protective rings around the regulator, they do not need to be chained in storage.

Particularly Hazardous Substances

Three classes of hazardous chemicals are defined by Cal/OSHA as 'Particularly Hazardous Substances' (PHS). These classes are: *carcinogens, reproductive toxins, and acute toxins*. (It is important to note that many substances present in the laboratory are new chemical entities that have not been subjected to any kind of toxicity or carcinogenicity testing, and should be handled with that in mind.) Special provisions must be established and documented in laboratory SOPs to prevent the exposure of laboratory personnel to these materials, including:

- Establishment of designated areas
- Use of containment devices (e.g. fume hoods)
- Procedures for contaminated waste disposal
- Decontamination procedure.

These requirements will be discussed in the Hazard Controls section.

Carcinogens

Carcinogens are chemical or physical agents that cause cancer. Generally, they exhibit chronic toxicity; that is, they cause damage after repeated or long-duration exposure, and their effects may only become evident after a long latency period. Chronic toxins of this kinds are particularly insidious because they may have no immediately apparent harmful effects (also referred to as 'warning properties'). Carcinogenic chemicals are separated into three classes:

- Select Carcinogens
- Regulated Carcinogens
- Listed Carcinogens

Select Carcinogens are materials which have met certain criteria established by the National Toxicology Program (NTP) or the International Agency for Research on Cancer (IARC) regarding the risk of cancer via certain exposure routes. The following references are used to determine which substances are select carcinogens by Cal/OSHA's classification

- Is a Listed Carcinogen
- Annual Report on Carcinogens published by the National Toxicology Program (NTP), 'known to be carcinogens' and 'reasonably anticipated to be carcinogens' lists.
- International Agency for Research on Cancer (IARC), Group 1 'carcinogenic to humans, Group 2A 'probably carcinogenic to humans, and Group 2B 'possibly carcinogenic to humans'.
- Is a Regulated Carcinogen.

Regulated Carcinogens are of a higher hazard class than the select carcinogens, and therefore there are additional provisions required for their handling, per Cal/OSHA 8 CCR Article 110. This may include personal exposure monitoring. When working with regulated carcinogens, it is particularly important to review and effectively apply the Standard Operating Procedure for PHS's. If it is found that a laboratory has exceeded the Cal/OSHA defined permissible exposure limit (PEL) for a regulated carcinogen, extensive additional regulatory requirements will apply to that laboratory. The regulated carcinogens are:

- Acrylonitrile
- Arsenic and inorganic arsenic compounds
- Coke oven emissions
- 1,2-Dibromo-3-chloropropane (DBCP)

- Asbestos
- Benzene
- 1,3-Butadiene
- Cadmium metal and cadmium compounds
- Chromium(VI) compounds
- Methylenedianiline (MDA)
- Vinyl chloride
- Ethylene dibromide (EDB)
- Ethylene oxide (EtO)
- Formaldehyde gas and solutions
- Lead and inorganic lead compounds
- Dichloromethane
- 4,4'-Methylene-bis(2-chloroaniline) (MBOCA)
- All Listed Carcinogens

Listed Carcinogens are the thirteen chemicals listed in 8 CCR §5209. These chemicals are considered to pose the highest carcinogenicity hazard. They have many additional requirement for use beyond those required for regulated carcinogens. Given these strict regulatory requirements for use, handling and storage, the campus Chemical Hygiene Officer must be contacted before any work is initiated. Purchases of these materials will also be routed to the Chemical Hygiene Officer for approval. The Listed Carcinogens are:

- 2-acetylaminofluorine
- 4-Aminodiphenyl
- Benzidine and its salts
- 3,3'-Dichlorobenzidine and its salts
- 4-Dimethylaminobenzene
- Alpha-naphthylamine
- Beta-naphthylamine
- 4-Nitrobiphenyl
- N-Nitrosodimethylamine
- Beta-Propiolactone
- Bis-chloremethyl ether
- Methyl chloromethyl ether (MOM-Cl)
- Ethyleneimine

Reproductive Toxins

Reproductive toxins include any chemical that may affect reproductive capabilities, including causing chromosomal damage (mutagenesis), effects on fetuses (teratogenenesis), and adverse effects on sexual function and fertility. Reproductive toxins can affect the reproductive health of both men and women if proper procedures and controls are not used. For women, exposure to reproductive toxins during pregnancy can cause adverse effects on the fetus; these effects include embryo lethality (death of the fertilized egg, embryo or fetus), malformations (teratogenic effects) and postnatal defects. For men, exposure can lead to sterility.

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

Mutagens are a class of materials that cause a change in the genetic material of a living cell. As such, they effect changes that can potentially lead to both reproductive toxicity and the development of cancer.

Acute Toxins

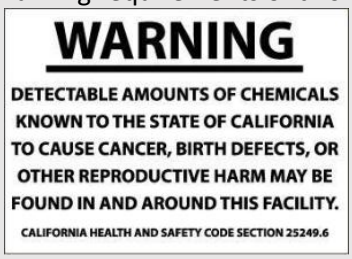
Acute toxins are substances that may be fatal as a result of a single exposure, or exposures of short duration, via one or more of three routes, defined as:

- ORAL: A chemical with a median lethal dose (LD_{50}) of 50 mg or less per kg of body weight.
- DERMAL: A chemical with a median lethal dose (LD_{50}) of 200 mg or less per kg of body weight.
- INHALED: A chemical that has a median lethal concentration (LC_{50}) in air of 500 ppm by volume or less of gas, 2.0 mg per liter or less of vapor, or 0.5 mg per liter or less of mist or dust, when administered by continuous inhalation for 4 hours (or less if death occurs within 4 hours)

Substances or mixtures classified by their manufacturer under GHS as Category 1 or 2 for acute toxicity meet this definition, and the associated hazard statement specifies that they are "fatal" via one or more of the three exposure routes.

Chemicals Known to the State of California to Cause Cancer or Reproductive Toxicity

The Safe Drinking Water and Toxic Enforcement Act of 1986, also known as Proposition 65, requires the state to publish a list of chemicals known to cause cancer or reproductive toxicity. It also requires businesses to provide warnings to Californians about significant exposure to the chemicals on the list. These chemicals can be in the products that Californians purchase, in their homes or workplaces, or that are released into the environment. The University of California, as a government agency, is exempt from the warning requirements of this law.



Toxic Substances

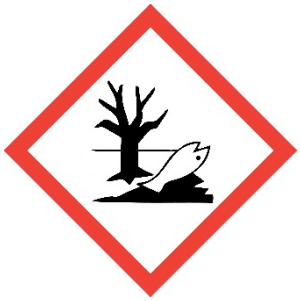
Substances which may cause toxicity as the result of a single exposure, but are typically not fatal in small does, are considered toxic. Substances classified as Category 3,4 and 5 under GHS for acute toxicity meet this definition*, and are not considered particularly hazardous substances (PHS)*.Category 3 substances are associated with the skull-and-crossbones pictogram. Category 4 and 5 are associated with the exclamation mark pictogram.

Substances which cause damage to target organs are also considered to be toxic, and are indicated under GHS by the same health hazard pictogram as are carcinogens and reproductive toxins. These include:

- Hepatotoxins: Substances that damage the liver. *Examples: nitrosamines, carbon tetrachloride.*
- Nephrotoxins: Substances that damage the kidneys. *Examples: certain halogenated hydrocarbons, ethylene glycol (antifreeze).*
- Neurotoxins: Substances that damage the nervous system. *Examples: mercury, acrylamide, carbon disulfide*.
- Hematopoetic agents: Substances that decrease hemoglobin function and deprive the body tissues of oxygen. *Examples: carbon monoxide, cyanide ion*.
- Respiratory toxins: Substances that damage the lung tissue. *Examples: asbestos, silica*.

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

Chemicals Hazardous to the Environment



Materials with demonstrated toxicity to aquatic organisms are classified as toxic to the environment. It is particularly important that such materials be stored in a manner which minimizes the risk of accidental release, and that they be disposed of as hazardous waste. As with all hazardous chemicals, any release to the environment must be reported to Environmental Health and Safety immediately.

Peroxide-Forming Chemicals

Materials that may form potentially explosive peroxides are not classified under GHS, but are of significant concern. These peroxides are much more shock-sensitive than TNT and are also sensitive to sparks or other accidental ignition. Many of these chemicals are common organic solvents and care must be taken in their use and storage. There are no specific regulations that address the handling, classification of, or control methods for peroxidizable materials. The information included here is considered best practice and is based on Prudent Practices in the Laboratory, Chapters 4 and 6.

Some moieties that are known to form peroxides include:

- Primary and secondary alkyl ethers
- Compounds with benzylic hydrogens
- Compounds with allylic hydrogens
- Compounds with a tertiary C-H group
- Conjugated polyunsaturated alkenes and alkynes
- Compounds containing secondary or tertiary C-H groups adjacent to an amide.

All peroxide-forming chemicals should be stored in airtight containers in a cool, dry area. If the container is transparent it should also be protected from light. Inventories should be carefully controlled, with the date of receipt and the date of opening marked on the label. There are three classes of peroxidizable chemicals, each with its own set of storage requirements. The three tables below are not comprehensive lists of each class, but are examples of each more commonly found in the laboratory.

Class A: Chemicals that form explosive levels of peroxides without concentration.

These chemicals form peroxides upon exposure to air, and continue to build peroxides to potentially dangerous levels. ***They are especially dangerous and must be discarded within 3 months of receipt or formation.***

Class A Peroxide-Forming Chemicals:

Isopropyl Ether	Sodium Amide
Butadiene liquid	Tetrafuoroethylene
Chlorobutadiene (chloroprene)	Divinyl Acetylene
Potassium Amide	Vinylidine Chloride
Potassium Metal	

Class B: Chemicals that are a peroxide hazard on concentration.

These chemicals form peroxides upon exposure to air, but develop a low equilibrium concentration. These chemicals become dangerous only when condensed via evaporation or distillation. The peroxide becomes concentrated because it is less volatile than the parent chemical. Note that with low boiling-point solvents such as diethyl ether, this concentration can occur while in storage. Thus, old bottles of peroxidizable low-boiling solvents can become dangerously shock-sensitive without any active effort to condense the liquid. Some of these materials are sold with inhibitors added to them, which does increase their shelf-life. However, users must be aware that distillations, condensations and other purification techniques will remove these stabilizers.

From the date of opening, ***Class B chemicals with inhibitors can be stored for 12 months, without inhibitors they can be stored for 6 months***. After this point, they should be discarded. All Class B chemicals past the manufacturer's expiration date should be discarded.

Class B Peroxide-Forming Chemicals

Acetal	**Dioxane**
Cumene	Ethylene Glycol Dimethyl Ether (Glyme)
Cyclohexene	Furan
Cyclooctene	Methyl Acetylene
Cyclopentene	Methyl Cyclopentane
Diacetylene	Methyl Isobutyl Ketone
Dicyclopentadiene	**Tetrahydrofuran**
Diethylene Glycol Dimethyl Ether (diglyme)	Tetrahydronaphthalene
Diethyl ether	Vinyl ethers

Common laboratory solvents in bold

Class C: Unsaturated monomers that may autopolymerize as a result of peroxide accumulation

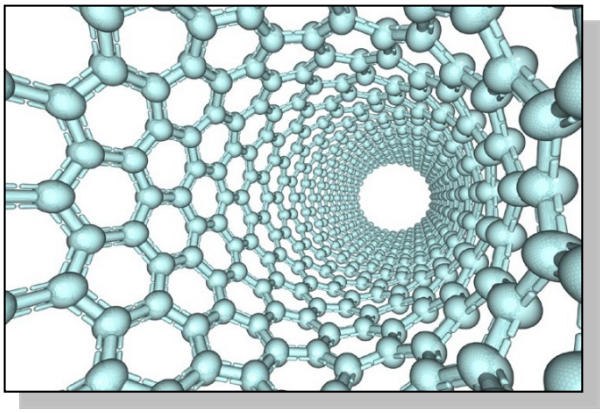
This class of compounds consists of inhibitor free monomers designed to undergo free-radical polymerization. Upon exposure to air, these compounds can form peroxides that then violently polymerize. Often they are sold with a polymerization inhibitor added. These inhibitors require the presence of oxygen to function, and therefore these products should not be stored under an inert atmosphere. As this can cause confusion, please refer to the manufacturer instructions and/or the SDS for storage requirements. ***Pure, uninhibited materials must only be stored for 5 days or less. Inhibited material may be stored for 12 months***.

Class C Peroxide-Forming Chemicals

Acrylic Acid	Styrene
Butadiene gas	Vinyl Acetate
Chlorotrifluoroethylene	Vinyl Chloride
Ethyl Acrylate	Vinyl Pyridine
Methyl Methacrylate	

If you find a container of peroxidizable material of unknown age or origin, isolate the immediate area and call EH&S at **(805) 893-3194**.

Nanomaterials



The increasing use of nanomaterials in research labs warrants consideration of the hazards they may pose. As is the case with many new technologies, the health effects of nanomaterials have not been thoroughly investigated. Consequently, the uncertainty surrounding the health hazards of nanomaterials merits a cautious approach when working with them.

Nanomaterials include any materials or particles that have an external dimension in the nanoscale (1-100 nm). Nanomaterials are both naturally occurring in the environment and intentionally produced. Intentionally produced nanomaterials are referred to as Engineered Nanomaterials (ENM). Materials whose properties do not differ significantly between their nanoscale and larger forms are generally excluded from ENMs. Some examples of ENMs include fullerenes, carbon nanotubes, carbon nanofibers, quantum dots and metal oxide nanoparticles.

The parent compound of the nanomaterial should also be taken into consideration when evaluating the potential hazards associated with exposure (e.g. a highly toxic compound such as cadmium should be anticipated to be at least as toxic and possibly more toxic when used as a nanomaterial). However, even materials which are non-toxic in their bulk phase (e.g. carbon) may display significant toxicity as nanomaterials (e.g. multiwall carbon nanotubes).

Naturally occurring nanomaterials like amorphous silica and carbon black have legal (Cal/OSHA) exposure limits (for these examples 80 mg/m^3 and 3.5 mg/m^3respectively). Currently, there are no legal exposure limits for engineered nanomaterials in the US or internationally. However, NIOSH (National Institute for Occupational Safety and Health) has developed Recommended Exposure Limits (RELs) for just two ENMs: carbon nanotubes (7 μg/m^3) and nano-titanium dioxide (0.3 μg/m^3).

Nanomaterials are categorized by the potential risk of exposure they pose to personnel based on the physical state of the materials and the conditions in which they are used. In general, the risk of exposure is lowest when nanomaterials are bound in a solid matrix with little potential to create airborne dust, or when in a non-volatile liquid suspension. The risk of exposure increases when nanomaterials are used as fine powders, are suspended in volatile solvents or gases, or are used in procedures capable of producing aerosols. The Nanotoolkit referenced below divides these materials into 3 categories, and assigns appropriate controls to each (Table 3.1). This allows researchers to develop a Standard Operating Procedure (SOP) for handling their ENM given these factors. In moderate to high exposure risk cases as determined by the Nanotoolkit, it is advisable to reach out to the EH&S Respiratory Protection Program for a consultation, as respiratory protection may be required. Personal Protective Equipment such as gloves should be chosen taking into consideration the nanomaterial as well as other chemicals being used in conjunction with them, such as solvents. Double gloving is advised.

Table 3.1

Risk level	Controls	
Category 1 Low Exposure Potential	Engineering	• Fume Hood or Biosafety Cabinet. Perform work with open containers of nanomaterials in liquid suspension or gels in a laboratory-type fume hood or biosafety cabinet, as practical.
	Work Practices	• Storage and labeling. Store in sealed container and secondary containment with other compatible chemicals. Label chemical container with identity of content (include the term "nano" in descriptor). • Preparation. Line workspace with absorbent materials. • Transfer in secondary containment. Transfer between laboratories or buildings in sealed containers with secondary containment. • Housekeeping. Clean all surfaces potentially contaminated with nanoparticles (i.e., benches, glassware, apparatus) at the end of each operation using a HEPA vacuum and/or wet wiping methods. DO NOT dry sweep or use compressed air. • Hygiene. Wash hands frequently. Upon leaving the work area, remove any PPE and wash hands, forearms, face, and neck. • Notification. Follow institution's hazard communication processes for advanced notification of animal facility and cage labeling/management requirements if dosing animals with the nanomaterial
	PPE	• Eye protection. Wear proper safety glasses with side shields (for powders or liquids with low probability for dispersion into the air) • Face protection. Use face shield where splash potential exists. • Gloves. Wear disposable gloves to match the hazard, including consideration of other chemicals used in conjunction with nanomaterials (refer to Table 1. Glove Choices for Nanomaterials) • Body protection. Wear laboratory coat and long pants (no cuffs). • Closed toe shoes.
Category 2 Moderate Exposure Potential	Engineering	• Fume Hood, Biosafety Cabinet, or Enclosed System. Perform work in a laboratory-type fume hood, biosafety cabinet* (must be ducted if used in conjunction with volatile compounds), powder handling enclosure, or enclosed system (i.e., glove box, glove bag, or sealed chamber).
	Work Practices	• Category 1 Work Practices. Follow all work practices listed for Category 1. • Access. Restrict access. • Signage. Post signs in area. • Materials. Use antistatic paper and/or sticky mats with powders.
	PPE	• Category 1 PPE. Wear all PPE listed for Category 1. • Eye protection. Wear proper chemical splash goggles (for liquids with powders with moderate to high probability for dispersion into the air). • Gloves. Wear two layers of disposable, chemical-protective gloves. • Body protection. Wear laboratory coat made of non-woven fabrics with elastic at the wrists (disposable Tyvek®-type coveralls preferred). • Closed toe shoes. Wear disposable over-the-shoe booties to prevent tracking nanomaterials from the laboratory when working with powders and pellets. • Respiratory Protection. If working with engineering controls is not feasible, respiratory protection may be required. Consult an EH&S professional for more information (i.e., N95 respirator, or one fitted with a P-100 cartridge).
Category 3 High Exposure Potential	Engineering	• Enclosed System. Perform work in an enclosed system (i.e., glove box, glove bag, or sealed chamber).
	Work Practices	• Category 2 Work Practices. Follow all work practices listed for Category 2.
	PPE	• Category 2 PPE. Wear all PPE listed for Category 2. • Body protection. Wear disposable Tyvek®-type coveralls with head coverage. • Respiratory Protection. If working with engineering controls is not feasible, respiratory protection may be required. Consult an EH&S professional for more information (i.e., N95 respirator, or one fitted with a P-100 cartridge).

For more information, see:

- The California Nanosafety Consortium of Higher Education's Nanotoolkit: Working Safety with Engineered Nanomaterials in Academic Research Settings,

- The National Institute of Occupational Safety & Health's (NIOSH) General Safe Practices for Working with Engineered Nanomaterials in Research Laboratories, and

- The National Institute of Occupational Safety & Health's (NIOSH) Current Strategies for Engineering Controls in Nanomaterial Production and Downstream Handling Processes.

Determining Hazard Classes

For materials obtained from outside suppliers, PIs/Laboratory Supervisors may rely on the hazard determination of the manufacturer. However, PIs/Laboratory Supervisors are responsible for making

reasonable determinations of the health and/or physical hazards of any *materials produced in their laboratories*.

The term 'hazardous substance' refers to any chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed individuals. PIs/Laboratory Supervisors may assume that any chemical of known composition produced in their lab is hazardous if it is listed in the following:

- Cal/OSHA's The Hazardous Substance List: 8 CCR §339, commonly referred to as the Director's List of Hazardous Substances.
- Cal/OSHA's Toxic and hazardous Substances, Air Contaminants: 8 CCR §5155.
- Threshold Limit Values for Chemical Substances in the Work Environment, ACGIH, 2009.
- Fourteenth Annual Report on Carcinogens, NTP, 2016
- Monographs, IARC, WHO
- Chemicals Known to the State to Cause Cancer or Reproductive Toxicity: Proposition 65, 22 CCR §12000,

Any chemical of unknown composition should be presumed to be hazardous. Chemical derivatives of known materials should be presumed to be at least as hazardous as their parent compound. In all such cases, PIs/Laboratory Supervisors should take appropriate steps to prevent exposure.

Chemical Hazard Communication

Employers are required by Cal/OSHA to provide information to their employees about the hazardous substances to which they may be exposed. Below are the main routes by which this information is disseminated.

Chemical Labeling

All chemicals in the laboratory should be properly labeled. Commercial chemicals come with a manufacturer's label which contains the necessary information. Care should be taken not to remove or deface these labels. For containers without manufacturer's labels, the following labeling requirements must be adhered to:

- All containers of hazardous materials must be labeled with the identity of the substance, legibly and in English. Acronyms (e.g. IPA) and chemical formulas alone do not fulfill this requirement.
- The label must contain applicable warning statements (e.g. Flammable, corrosive).

- Particularly Hazardous Substances (PHS) must also be labeled with the specific hazard that meets the definition of PHS (e.g. Acute Toxin, Carcinogen, Reproductive Toxin). Additionally, *the storage area where PHS's are kept must also be labeled with the type of hazard*. These chemicals should be segregated from other chemicals to help with proper access control and hazard identification.

- Peroxide forming chemicals must be labeled with the *date of receipt and the date of opening*.

Safety Data Sheets (SDS)

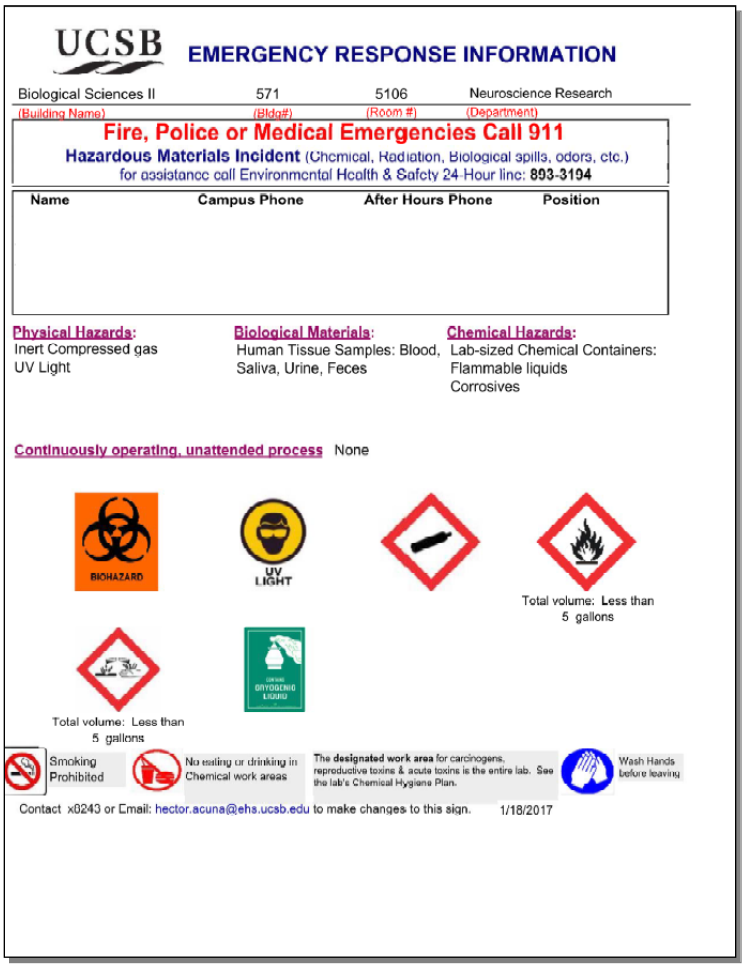
An SDS must be available for each hazardous substance in a laboratory's chemical inventory. PI's/laboratory Supervisors are responsible for ensuring that all researchers have immediate access to SDS's, and are trained on how to access them, as well as understanding their relevance to the health and safety of the workplace. (SDS format and access requirements are covered in the mandatory EH&S Fundamentals of Laboratory Safety class.) Access may be either physical or digital.

Like the hazard class pictograms, SDS format and content have been standardized by the Globally Harmonized System. Chemical manufacturers are required to provide updated SDS's. The required 16 sections of an SDS are:

1. Identification of the substance or mixture, and of the supplier
2. Hazard Identification
3. Composition/information on ingredients.
4. First Aid measures
5. Firefighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure control/personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information, including information on preparation and revision of the SDS

Some useful links for accessing SDS's on line are located on the EH&S website.

Figure 3.1



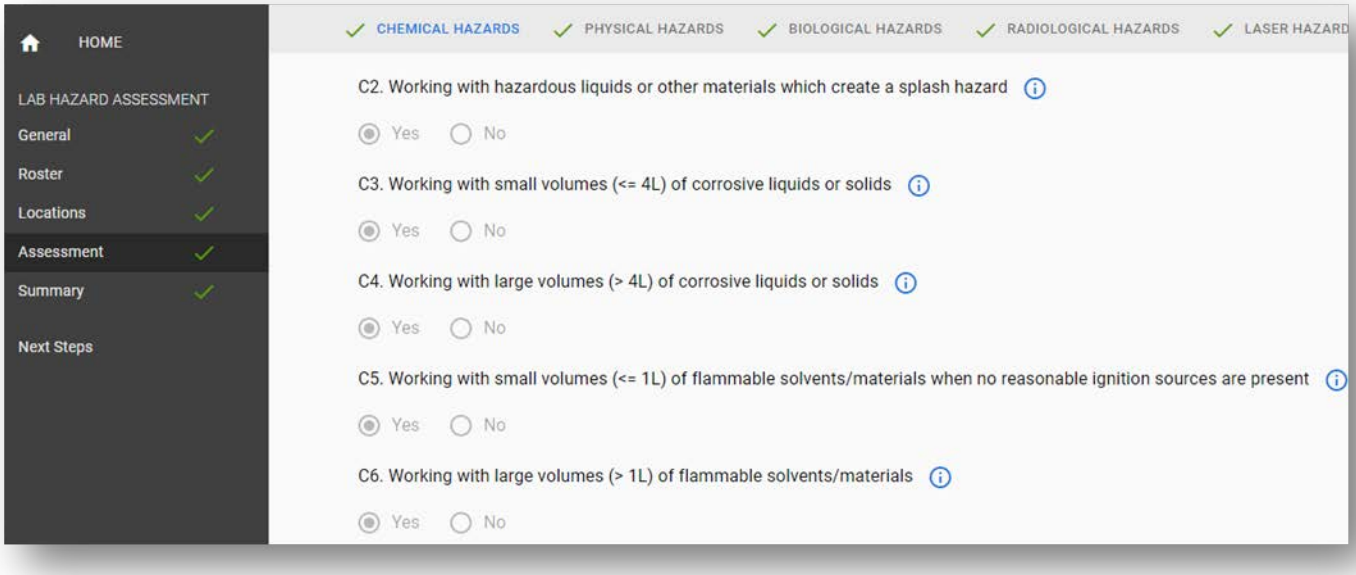
Door Placards

To aid emergency responders, every corridor entrance to laboratories has a placard conveying information regarding the types of hazards within and laboratory emergency contacts (Figure 3.1). The information is updated annually, but laboratories should submit a new EH&S door placard form if the placard becomes out of date at any time.

Lab Hazard Assessment Tool (ASSESSMENT)

As described in the Section II, Chapter 2, ASSESSMENT, the new laboratory hazard assessment tool, was developed as a method for identifying and communicating the hazards that are present in each laboratory via a set of guided questions (**Figure 3.2**). As such, it is a key component to the hazard communication process for reducing workplace illness and injury

Figure 3.2



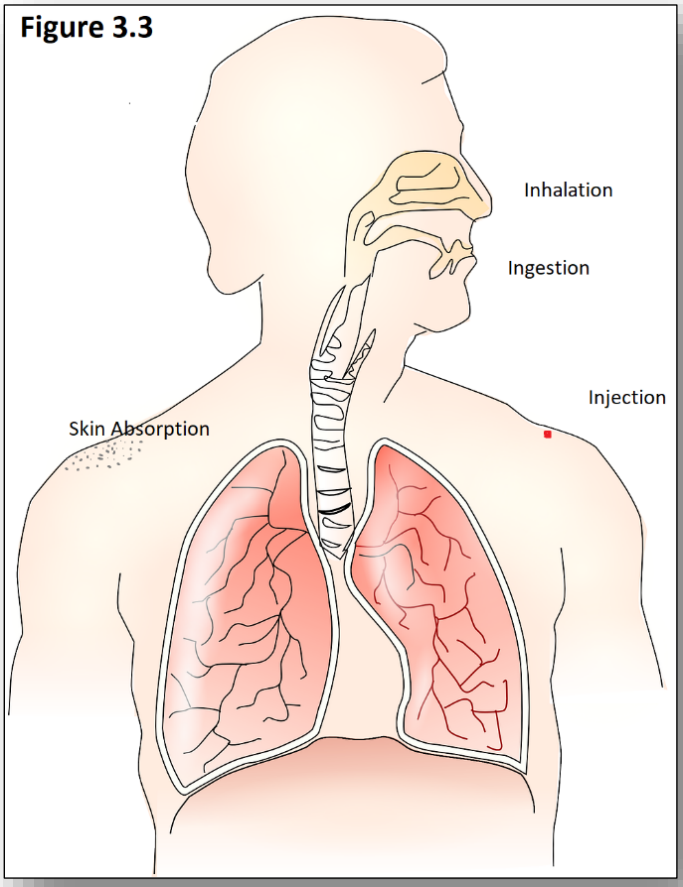
How to Reduce Exposures to Hazardous Chemicals (Hazard Controls)

There are four primary routes of exposure for chemicals that have associated health hazards (Figure 3.3):

1. Inhalation: e.g. breathing in chemical fumes
2. Ingestion: e.g. eating contaminated food in the lab
3. Absorption (through skin or eyes): e.g. chemical splash
4. Injection: e.g. contaminated needle stick or uptake through an existing wound

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

Figure 3.3

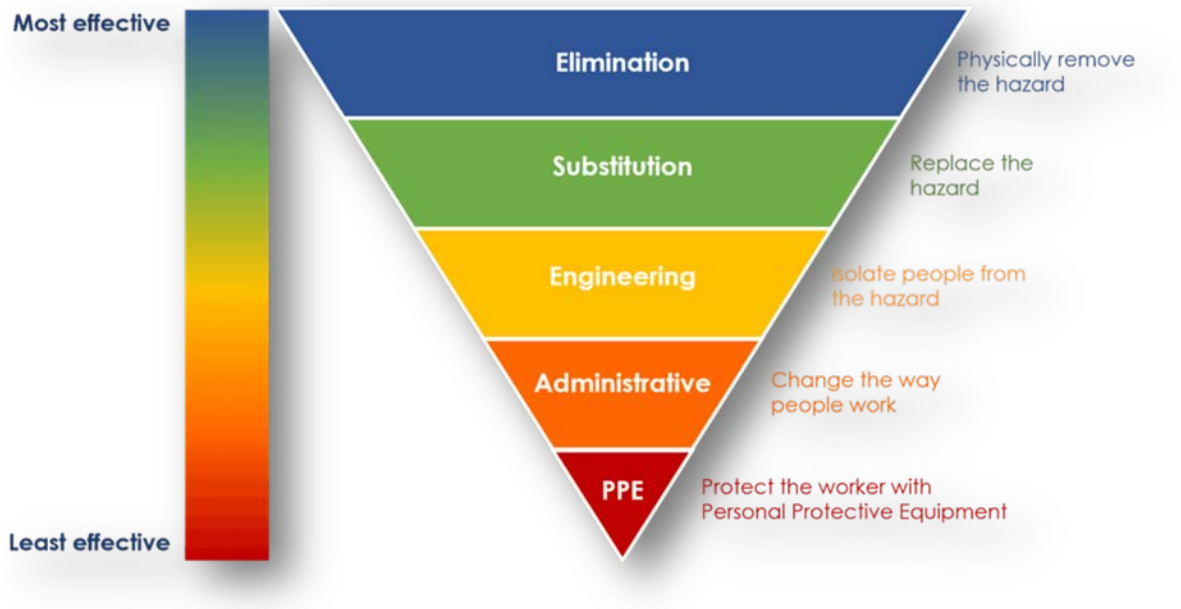


The methodologies for controlling exposures to hazardous chemicals are termed 'Controls'. Each type of control is designed to reduce the *risk* of interacting with a material and its inherent *hazards*. It requires a carefully considered, multi-tiered system of safety controls to effectively manage the risks associated with exposure to these chemicals.

Broadly, safety controls can be divided into four classifications: Elimination, Substitution, Engineering Controls, Administrative Controls, and Personal Protective Equipment.

In figure 3.4, each of these control types are ordered according to their effectiveness. Elements of all of these are used in a layered approach to create a safe working environment. The principles of each of these control types are detailed below.

Figure 3.4: The Hierarchy of Controls



Elimination and Substitution

The only way to reduce to zero the risk of interacting with a particular hazard is to remove that hazard completely. Thus, elimination is considered to be the most effective safety control. As this is often not practical in the laboratory, the next-best approach is to substitute the hazard with something less hazardous. Examples of substitution might include substituting toluene for benzene as a reaction or purification medium.

Engineering Controls

The National Institute of Occupational Safety and Health (NIOSH) states that:

> "Engineering Controls are used to remove a hazard or place a barrier between the worker and the hazard… Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection."

Following Elimination and Substitution these controls offer the first line of protection to prevent exposures to hazardous chemicals. As noted in the excerpt above, they require minimal alteration of procedures on the part of the researcher (except in emergency situations) and therefore are less prone to user error than

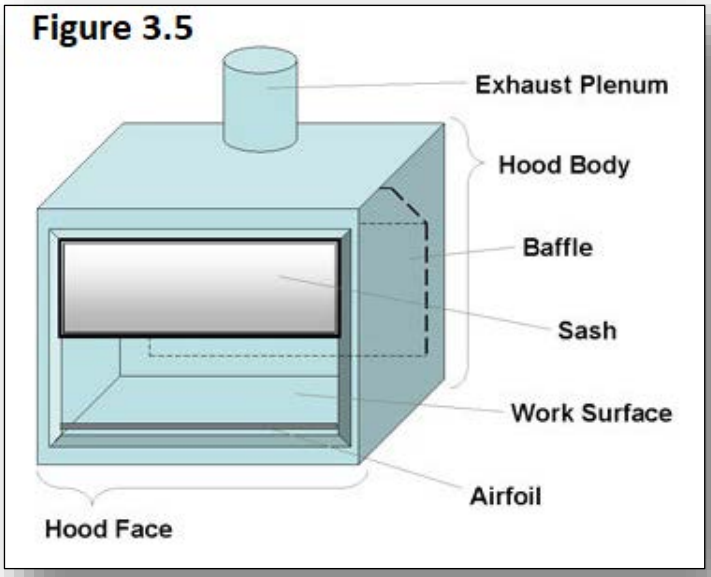
other control methods. A fundamental and very common example is the laboratory fume hood, which is very effective at containing chemical fumes and vapors, and thereby protecting users from inhalation hazards. Other examples of engineering controls include flammable material storage cabinets, snorkels, and general room ventilation.

General Laboratory Ventilation

Per California Fire Code and the University of California Lab Safety Design Manual, laboratory spaces where hazardous materials are used or stored have mechanically generated and conditioned supply and exhaust air. The intakes supply outside fresh air, and the exhausts vent 100% to the outside, with no return of fume hood and laboratory general exhaust back into the building. The total volume of exhaust air should meet a minimum of 1 cfm/ft^2, or roughly 6 air changes per hour. Laboratories are kept at negative pressure to adjoining non-laboratory spaces (e.g. the hallway) to prevent the spread of airborne hazards.

Fume Hoods

Chemical fume hoods are the most commonly used local exhaust system on campus, and are one of the most important pieces of equipment used to protect workers from exposure to hazardous chemicals. Other examples of local exhaust systems include vented enclosures for large pieces of equipment or chemical storage, and movable exhaust systems for capturing contaminants near the point of release, a.k.a. snorkels. Figure 3.5 shows the key components of a fume hood.



There are two categories of chemical fume hood on campus: Constant Air Volume (CAV) and Variable Air Volume (VAV). As the name suggests, Constant Air volume (CAV) hoods always remove the same volume of air per unit time from the room, regardless of sash height. These hoods are calibrated such that the Cal/OSHA required working airflow rate of at least 100 linear feet per minute (fpm) averaged over the opening of the hood is achieved when the movable sash is placed at the marked working height of 18 inches. Sash heights greater than 18 inches produce an airflow rate below 100 fpm, which is not suitable for working with hazardous materials. Sash heights greater than 18 inches may be used for installation of equipment and other operations that do not present a chemical exposure hazard. All hoods are required to have at least one type of continuous monitoring device designed to provide the user with current information on the operational status of the fume hood. CAV hoods will have one of the following performance indicators attached to them: magnehelic gauges or electronic flow alarms, shown in figure 3.6. Magnehelic gauges do not provide an audible alarm

when the flow rate of the fume hood has deviated from normal. Rather the user must visually check the gauge for deviations. The electronic flow alarms have an audible alarm that alerts the user of hood malfunction.

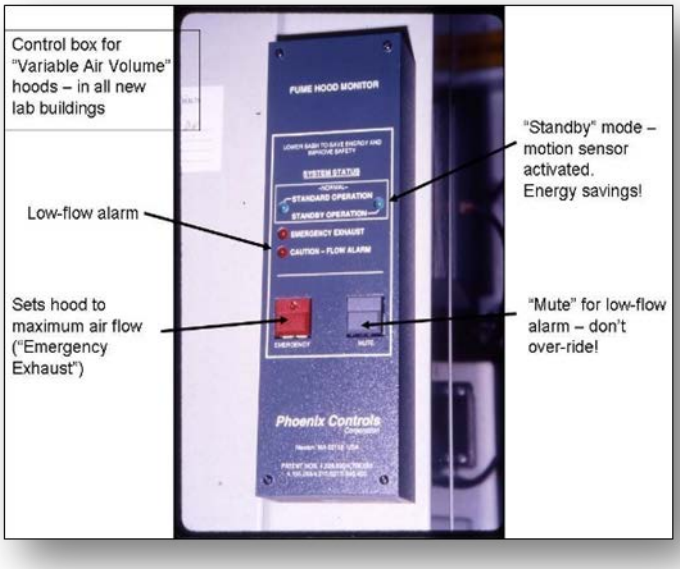
Figure 3.6

Magnehelic Gauge: Visual/non-audible

Electronic flow alarm: Visual and audible

Variable Air Volume (VAV) hoods are equipped with valves and sash height sensors that allow the hood to achieve 100 fpm at any sash height. However, this is an energy saving feature, and the working sash height is still 18 inches. The presence of the sash created a barrier between the worker and the materials in the hood and therefore protects from splash hazards, etc. For VAV hoods, the required monitoring device consists of a hood monitor box as shown in figure 3.7. In addition to providing an audible alarm indicating inappropriate airflow, it also has indicators for when the hood is in 'standby mode' (no worker present, airflow at 60 fpm) vs. standard mode (worker presence detected by motion detector, airflow at 100 fpm average). These hoods also have an 'emergency exhaust' button which ramps the airflow up to maximum. This setting should only be used during emergencies, as it can disrupt and knock over items in the hood.

Figure 3.7



Publication date November 8, 2021

Additional fume hood types include those designed for use with strong corrosives like hydrofluoric acid (acid hoods), and the potentially explosive perchloric acid (Perchloric acid wash-down hoods). If you are using either of these materials, please contact EH&S for a hazard assessment and safety equipment evaluation.

Fume hoods should be used when working with all hazardous substances. In addition, a fume hood or other suitable containment device **must** be used for all work with Particularly Hazardous Substances (PHS). A properly operating and correctly used fume hood can reduce or eliminate inhalation hazards present when working with volatile liquids, dusts and mists. When hazardous materials are present in a hood, but it is not under active use (such as during unattended operations), the movable sash should be completely closed. Fume hoods are not designed to be used as storage areas, and are not to be used as such unless no other operations are conducted in that hood.

General Rules for Fume Hood Use

1. **Fume hoods should not be used unless they have a certification sticker that is dated within the past year.**
2. **Before beginning work, check the hood monitoring device to confirm proper hood function.**
3. **Always keep hazardous materials >6 inches behind the plane of the sash.**
4. **Work with the movable sash at the marked 18 inch working height.**
5. **For walk-in style hoods, where the hood and sashes extend to the floor of the lab, keep the sash opening as small as possible as a large opening can create difficulty in maintaining airflow and allows for turbulence.**
6. **Do not clutter your hood, as this blocks airflow and provides fuel for any potential lab fire. Only materials actively in use should be present.**
7. **Do not modify hood, duct work, or the exhaust system without prior EH&S approval.**
8. **Do not use hood as a storage area for chemicals or large equipment unless the hood is dedicated to one of these functions.**
9. **Close the sash when the hood is not in active use.**

Fume hoods are evaluated for operation and certified by EH&S on an annual basis. Hoods certified for use with certain regulated carcinogens are evaluated semi-annually. These evaluations verify the proper fume hood air flow velocity (100 fpm) to ensure that the unit will operate as designed. Data on fume hood monitoring is maintained by EH&S. Additionally, they must be inspected upon installation, renovation, a problem is reported, or a change has been made to the operating characteristics of the hood. A fume hood must have a current calibration sticker and a marker indicated the sash height to be used when working with hazardous materials (18 inches). If these labels are missing, do not use the hood, and contact EH&S at 805-893-3194 for an immediate fume hood evaluation. Routine maintenance and repair of fume hoods are conducted by Facilities Management. If any problems with the fume hood occurs, or if the audible alarm is going off, contact Facilities Management at 805-893-8300.

Somewhat related to chemical fume hoods are laminar flow hoods and biosafety cabinets. The key differences are summarized in figure 3.8. Laminar flow hoods generally do not offer personnel protection, and therefore are not considered engineering controls. The exception is exhausted laminar flow hoods, which are connected to building exhaust and do not recycle air back into the laboratory. Biosafety cabinets do offer personnel protection, as well as environmental protection from biohazardous material. Note that many biosafety cabinets recirculate air back into the laboratory after it passes through a high efficiency HEPA filter. These filters do not remove chemical contamination. Therefore, **never use volatile hazardous chemicals in a recirculating biosafety cabinet**. For biosafety cabinets that are exhausted to the outside of the building, keep the use of hazardous chemicals to a minimum, as these cabinets are not designed with chemical fume protection as a primary consideration. Further training on biosafety cabinets is provided in the mandatory BSL-2 and Blood Borne Pathogen training, as well as hands-on by the PI or delegate.

Figure 3.8

Protection	Biosafety Cabinet Class II type A2	Chemical Fume Hood	Laminar Flow Hood
Personnel	Yes	Yes	No*
Product	Yes	No	Yes
Environment	Yes	No	No

*Unless hard-ducted to building exhaust

Glove Boxes

In addition to fume hoods, some laboratories use glove boxes, also known as dry boxes, for working with reactive chemicals under an inert atmosphere, working with very toxic substances, or for creating a stable, draft-free system for weighing hazardous or reactive materials (Figure 3.9). These units require specialized, hands-on training on proper use, and this training must be documented.

Figure 3.9 Glove Box

Hazardous Materials Storage Equipment

Beyond the handling of hazardous materials, engineering controls also come into play in the storage of these materials. Due to these strict mandates regarding flammable chemical storage outlined in the California Fire Code, one of the most important storage devices is the flammable storage cabinet (figure 3.10). Others include 'de-sparked' refrigerators and freezers, and compressed gas cylinder mounts. These are discussed at length later in this document in the section Chemical Inventory, Storage and Transport.

Figure 3.10: Flammable Storage Cabinets

Administrative Controls

Administrative controls consist of policies, procedures and trainings designed to reduce or prevent exposures to laboratory hazards. These controls require the user to exhibit strong situational awareness and act prudently while in the laboratory. This behavioral element is the reason administrative controls are placed one tier below engineering controls in the hierarchy of controls.

General Laboratory Practices

PI's/Laboratory Supervisors are strongly encouraged to establish and document clear rules for the following activities:

- *Working alone in the laboratory*. A laboratory-specific Standard Operating Procedure (SOP) that defines those laboratory activities that may not be undertaken while alone in the laboratory should be included with other laboratory SOP's.

- *Unattended laboratory operations*: Some requirements might include a posted description of the operation, the use of a thermocouple and over-temperature shutoff, and the use of flow sensors for cooling water.

- *Modifying a laboratory specific SOP* in such a manner that the overall hazard is increased substantially. A prime example of this is the scale-up of a chemical reaction. It is strongly recommended that the PI/Laboratory Supervisor establish upper limits for the quantities of materials used in the cases of potentially explosive, extremely reactive and acutely toxic chemicals, and require prior approval for work when these limits are exceeded.

Standard operating Procedures

To supplement the general guidance regarding laboratory work with chemicals that is contained in this Chemical Hygiene Plan, PI's/Laboratory Supervisors are required to develop and implement laboratory-specific SOP's for hazardous chemicals that are used in their laboratories per Cal/OSHA regulation 8 CCR §5191 (e)(3)(A). The development and implementation of SOP's is a core component of promoting a strong safety culture in the laboratory and helps ensure a safe work environment. These SOP's should be written by laboratory personnel who are most knowledgeable and involved with the chemical/operation involved. Completed SOP's must be approved and signed by the PI/Laboratory Supervisor. Factors to consider when writing an SOP, in addition to the hazards inherent to the material, include frequency of use, ranges in scale, temperature, and pressure, and *circumstances requiring prior approval by the PI/Laboratory Supervisor*. To assist researchers with this effort, an SOP template library has been created that contains templates that cover all hazard classes of chemicals, plus a number of chemical specific SOP's. EH&S is available to assist researchers in filling out the required fields and thereby creating a completed SOP, and in developing an SOP from scratch if a suitable template is not available.

SOP's shall be reviewed, and revised as needed, when one of the following criteria is met:

- Hazard level is altered due to changes in experimental conditions such as temperature, pressure, or scale.

- Equipment changes.

- An unexpected outcome occurs, resulting in a reassessment of the hazard/risk profile.

SOPs should be maintained along with this Chemical Hygiene Plan in hardcopy and/or electronic format and be readily available to laboratory personnel. All lab members must read and sign the Chemical Hygiene Plan and their research group's associated SOP's before entering the laboratory.

Particularly Hazardous Substances

Additional administrative controls must be implemented in order to work safely with PHS's. These include:

- Establishment of designated areas.
    - Can be as small as a single fume hood, but often encompasses the entire lab.
    - Only personnel trained on PHS use have access to the designated area.
    - The designated area should be designed in a way that will contain spills to that area.

- Containment devices (e.g. fume hoods) MUST be used at all times while handling PHS, to ensure there is no worker exposure.

- Segregated and clearly labeled storage areas exclusively for PHS must be provided.

- Procedures for contaminated waste disposal.

- Decontamination procedures must be followed: Work surfaces should be decontaminated upon completion of work. Soap and water are effective for removing most chemical residues, however some chemicals require the use of specific agents (e.g. hypophosphorous acid for inactivation of ethidium bromide).

A searchable list of Particularly Hazardous Substances has been generated by EH&S and is updated annually.

Laboratory Hazard Assessments

As mentioned previously, each PI/Laboratory Supervisor with assigned laboratory space is required to create a hazard assessment for their laboratory. The online ASSESSMENT tool is used to generate and document this assessment, as well as to share this assessment with all group members. In addition to being an administrative control, at UC Santa Barbara it has the additional role of determining what forms of personal protective equipment are necessary to protect the workers from the hazards identified.

Personal Protective Equipment and Appropriate Laboratory Attire

Personal Protective Equipment (PPE) serves as a researcher's last line of defense against chemical exposures and is required by everyone entering a laboratory containing hazardous chemicals. Specific requirements for PPE use and proper laboratory attire are outlined in the UC Personal Protective Equipment Policy. These requirements include, but are not limited to:

- Full length pants and close-toed shoes, or their equivalent.

- Protective gloves, laboratory coats, and eye protection when working with, or adjacent to, hazardous chemicals.

- Flame resistant laboratory coats when working with high hazard materials, pyrophorics, and flammables.

The goal of PPE is to reduce the risk associated with handling hazardous materials and conducting hazardous operations. In some cases, PPE beyond that described above will be required. For example, in cases of high splash hazard, chemical safety goggles may be required in the place of safety glasses, as the goggles form a seal around the face which isolates the eyes more completely from the hazard.

Note that prescription street glasses are not adequate eye protection in the laboratory! The lack of side shields and impact resistant lenses leaves the workers eyes exposed to hazards and susceptible to injury. Safety glasses must have these features and possess the ANSI Z87.1 certification stamp on the lenses or frames to be considered protective eyewear. Wearers of prescription glasses can either purchase prescription safety glasses, or wear over-the-glasses safety glasses or goggles.

The specific type of PPE needed for each worker is determined by the laboratory hazard assessment created by the PI/Laboratory Supervisor in the ASSESSMENT tool. Upon logging on, the worker will be directed to read the hazard assessment and watch a brief PPE training video. **A PPE voucher will then be generated by the tool which lists the required PPE for that worker. This voucher can be redeemed for free PPE at the campus PPE distribution center located in the Chemistry Building (557) room 1432**. This process also documents the issuance of the PPE to that individual.

How to Use and Maintain PPE

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

Gloves should be used under the specific condition for which they are designed, as no glove is impervious to all chemicals. Single-use disposable gloves protect only from incidental exposure (e.g. a drop of liquid on the glove) and generally only provide protection for a few seconds. Once contaminated, the glove should quickly be removed and disposed of, the hands washed, and a fresh pair of disposable gloves donned. These gloves should not be used for any operation in which immersion or soaking of the glove is expected, such as rinsing glassware with acetone. For these operations, the appropriate thicker, multiple-use glove should be used (butyl gloves for the acetone example given). Glove manufacturers generally provide glove compatibility charts for their products. Some useful examples are:

- Microflex Chemical Resistance Guide
- Cole Parmer Safety Glove Chemical Compatibility Database
- Ansell Guardian Partner Chemical Protection Guide

In cases where spills or splashes of hazardous chemicals on clothing or PPE occur, the clothing/PPE should immediately be removed and placed in a closed container to prevent further release of the chemical. Heavily contaminated clothing/PPE, as well as PPE contaminated with particularly hazardous substances (PHS) should be disposed of as hazardous waste. Non-heavily contaminated laboratory coats should be cleaned and properly laundered. **Coats can be dropped off at any of eight designated laundry locations on**

campus. The clean coats are returned to the same drop-off location within two weeks. Under no circumstances should laboratory coats be laundered at home or at commercial laundromats.

Respiratory Protection

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

Per Cal/OSHA regulation 8 CCR §5144 and UCSB Campus Policy, *all UCSB personnel who use respiratory protection equipment including filtering facepiece respirators (dust masks) shall be included in the UCSB Respiratory Protection Program*. The primary objective of the UCSB Respiratory Protection Program is to prevent harmful exposures to hazardous atmospheres through:

- Elimination of hazardous atmospheres wherever possible through the implementation of effective control measures.
- Where adequate control measures are not feasible, the use of respiratory protection to ensure exposures to hazardous atmospheres do not exceed applicable exposure limits.

Respiratory protection must be selected carefully as most respirators only provide protection against certain types of contaminants within specific concentration ranges. The UCSB Respiratory Protection Manual outlines local requirements for respirator use by campus personnel. These requirements include respirator training, fit testing and a medical evaluation.

The Office of Environmental Health and Safety shall act as the sole source for purchasing, fitting and approving the use of all respiratory protection equipment on campus.

Good Laboratory Practices

In order to maintain a safe workplace, certain basic working habits must be exercised. In the laboratory setting these practices and behaviors address the reduction in risks associated with chemicals, equipment, and sources of physical hazards such as electricity, among other things. Some of these habits are described below.

Chemical Handling

- Use only those chemicals for which the available ventilation system is appropriate. If you are unsure, contact EH&S.
- Review all relevant SDS's and SOP's before beginning a novel operation.
- Properly label and store all chemicals. All chemicals not in immediate use should be in their storage area, not on lab benches or fume hoods.

- Dispose of hazardous waste according to UCSB waste disposal procedure. Do not pour hazardous waste down the drain.

- Be prepared for an accident or spill and refer to the emergency response procedures for the specific material. Information on minor spill mitigation can be found in Chapter 4. For larger spills, or if you are not comfortable addressing the spill for any reason, contact EH&S. In the case of personnel exposure to the:

    - EYE: Promptly flush eyes with water for 15 minutes, then seek medical attention. Bring SDS with you to the medical facility.

    - SKIN: Promptly flush the affected areas for 15 minutes and remove any contaminated clothing, then seek medical attention. Bring SDS with you to the medical facility.

Physical Hazard Handling

In addition to chemical hazards, there are a number of physical hazards that are common in the laboratory setting. These include: pressure and vacuum, sharps, electricity, noise, vibration, temperature extremes, and kinetic energy. Some good practices relating to these physical hazards are:

- Store laboratory glassware with care. Inspect all glassware and other equipment before use; do not use damaged items.

- Use proper syringe techniques. Do not re-sheath used disposable needles.

- Compressed gas cylinders: inspect for damage/corrosion on a regular basis. Use a pressure regulator that is compatible with the bas being used. Check plumbing for leaks. Be aware of the possibility of an oxygen deficient atmosphere being created if the full contents of the cylinder are released rapidly, as upon rupture of the cylinder. Carbon monoxide detectors are easy to purchase and relatively inexpensive. When using carbon monoxide, place a CO detector near plumbing joints or other areas where a leak might occur. Contact EH&S to assess the need for oxygen or other gas monitors.

- Cryogens (Liquid nitrogen and helium, dry ice): Store and transfer only in approved storage vessels. Wear cryogenic gloves when handling. A face shield may be required if there is a significant splash hazard. Be aware of the possibility of an oxygen deficient atmosphere upon the evaporation of the cryogen. Contact EH&S to assess the need for oxygen or other gas monitors.

- Shielding: In situations where explosion (high pressure or high reactivity) or implosion (vacuum) are a possibility, use appropriate shielding to protect from flying fragments and other material. Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur.

- Electrical Hazards: Do not overload circuits. Do not 'daisy chain' extension cords or power strips. Examine wires for fraying. Do not use extension cords as permanent wiring. Contact Facilities if additional electrical outlets are needed.

- Noise: Loud workspaces are assessed by EH&S, and hearing protection is provided as necessary.

General Laboratory Operations

- Good housekeeping is key to a safe laboratory. Some good practices include:
    - Keeping work areas, especially fume hoods, clean and uncluttered.
    - Preventing the accumulation of dirty glassware, unneeded samples, and trash.
    - Keeping aisles and areas around safety shower/eyewash units clear to allow unobstructed exit and easy access to safety equipment in an emergency.
    - Practicing good refrigerator/freezer management by preventing overcrowding, using secondary containment, and completing periodic defrosting procedures.

- Prudent laboratory behavior is also important. Examples include:
    - Do not engage in distracting behavior such as practical jokes in the laboratory, as this can distract or startle other workers.
    - Wash your hands often, and again before leaving the laboratory.
    - Avoid working alone in the laboratory. If work must be conducted alone, restrict this work to that which does not involve significant chemical or physical hazards.
    - Do not bring or consume food/drink in any areas where hazardous materials are stored and handled.
    - Do not handle personal mobile devices while wearing gloves. Do not set a mobile device down on any surface in the lab which may be contaminated with hazardous chemicals.

- Seek information and advice about hazards, plan appropriate protective procedures, and plan positioning of equipment before beginning any new operation.

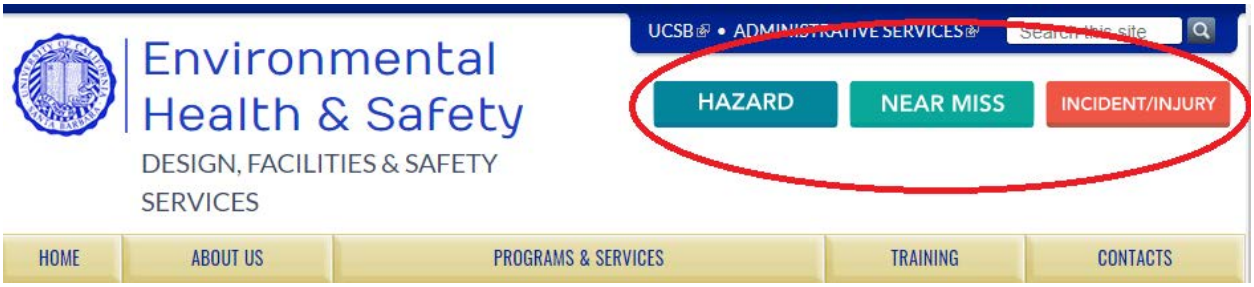
- Be alert to unsafe conditions and ensure that they are corrected when detected.

- If minors are in the laboratory, be sure to follow the UC Policy on Minors in Laboratories and Shops.

- For unattended laboratory operations, ensure that the operation has been approved by the PI/Laboratory Supervisor, the lab or fume hood door has signage in place describing the operation and associated hazards, the lights are left on, and make provisions for the loss of utility service (electricity, flowing water).

- Do not disturb equipment in use or any other laboratory operation without the consent of the user.

- Report all accidents, injuries and near-misses to the PI/Laboratory Supervisor and to EH&S. We cannot learn from these incidents if they are not reported.



- Report all fires to EH&S, and the discharge of any fire extinguisher to Facilities Management at 805.893.8300

Chemical Inventory, Storage, and Transport

Chemical Inventory

An accurate chemical inventory is a necessary part of a healthy chemical hygiene program. Certain minimum requirements for the quality and quantity of chemical inventory data are set by a variety of regulatory agencies. These are:

Local regulations (Santa Barbara County Environmental Health Services)

- Hazardous Materials Business Plan: The County requires businesses to provide information about their bulk hazardous materials, including location, physical state, container type, amount present and maximum amount stored on site during the year. The County uses the information for emergency response planning. For UCSB laboratories and shops to be in compliance they must report any hazardous materials to EH&S which at any one time during the year will be stored in quantities greater than:
    - 500 pounds of a solid.
    - 55 gallons of a liquid.
    - 200 cubic feet of a compressed gas, excluding inert gases, when the volume is calculated at standard temperature and pressure (STP).

- California Accidental Release Prevention Program (CalARP): The purpose of the CalARP program is to prevent accidental release of substances that can cause serious harm to the public and the environment. As such, businesses that handle more than a threshold quantity of a regulated substance are required to report this to the County, and to develop a Risk Management Plan (RMP).

State Regulations

- The California Fire Code (CFC): Title 24 of the California Fire Code defines Maximum Allowable Quantities (MAQ) for certain classes of chemicals, including flammables, oxidizers, pyrophoric/water reactive materials and highly toxic materials. The MAQ's vary depending on building construction and floor above or below ground, and therefore both quantities and location data must be collected for these materials.

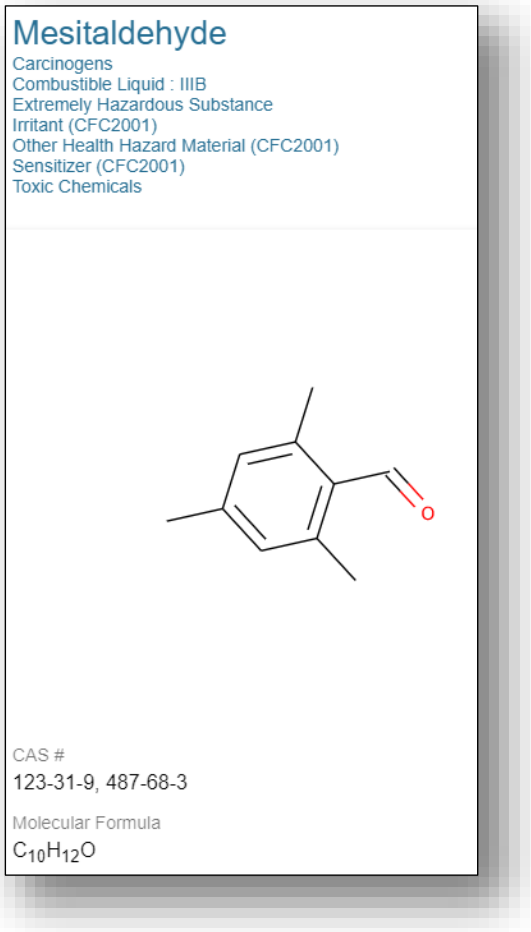
- Regulated Carcinogens (Cal/OSHA): These chemicals have very specific handling requirements, including the establishment of designated areas. Therefore, their presence and location on campus must be documented.

Federal Regulations

- Chemical Facility Anti-Terrorism Standards (CFATS): This standard covers a list of chemicals that are of interest to the Department of Homeland Security. The campus is required to report to DHS upon crossing designated threshold amounts of these chemicals. These quantities are calculated for the campus as a whole.

To obtain the data required to comply with these mandated programs, EH&S reviews the annual Laboratory Hazardous Materials Survey with each PI/Laboratory Supervisor during the annual laboratory safety review. All of the required data as described above is compiled via these survey forms, and entered into UC Chemicals, a web-based chemical inventory database.

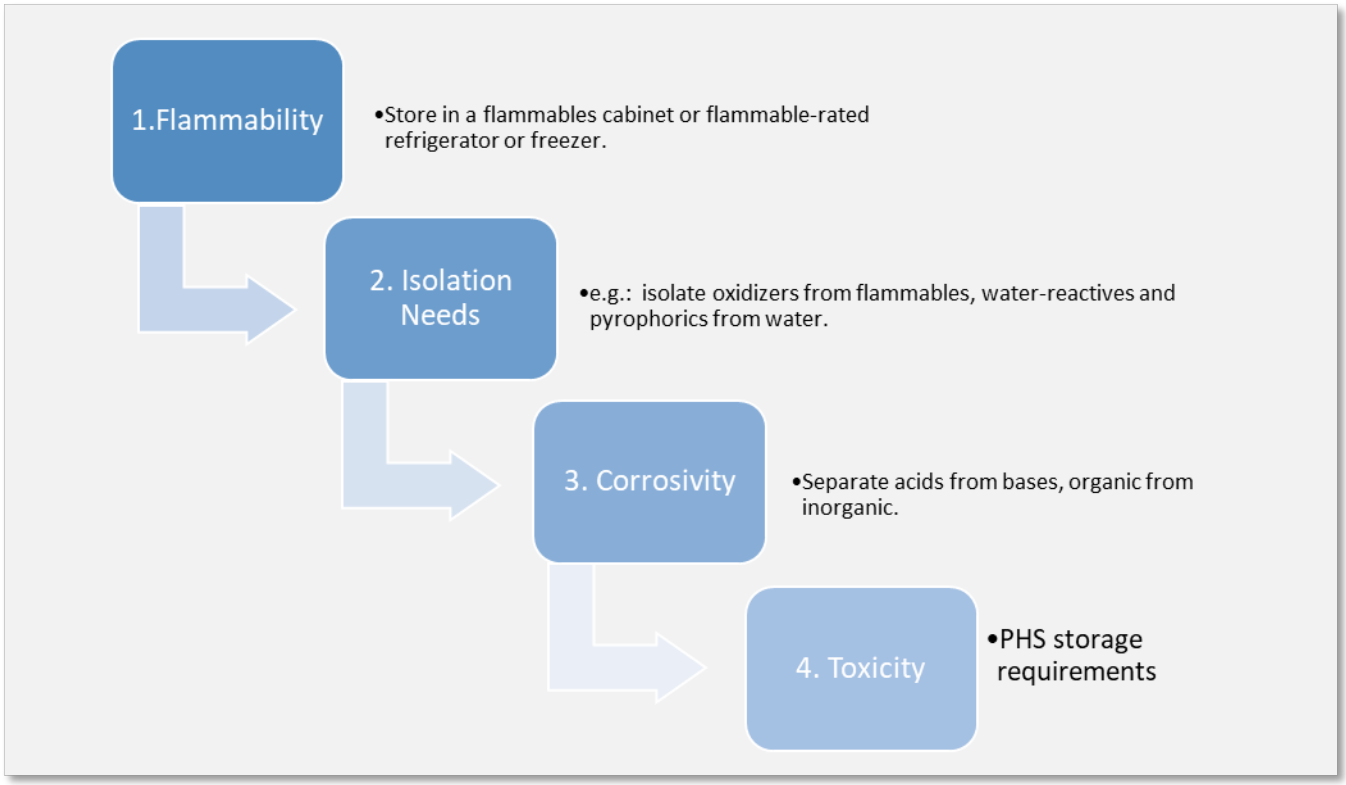
UC Chemicals can also be used directly by the research groups to manage their entire chemical inventory. This is best practice, and encouraged by UC Santa Barbara. Having a complete real-time inventory of all the chemicals in a laboratory, as opposed to just the chemicals required by the above regulations, has a number of benefits. First, it gives the researchers a high-resolution knowledge of all of the chemical hazards present in the laboratory. Second, it aids in the financial and time management of laboratory activities by reducing duplicate ordering, and avoiding delays caused by awaiting the delivery of a chemical reagent that is actually already present in the laboratory. Finally, it helps reduce diversion of chemicals (acquisition for illegitimate or illegal purposes).



Chemical Storage

It is important to establish and follow safe chemical storage and segregation procedures in the laboratory. Storage guidelines for flammable, oxidizing, corrosive, water reactive, explosive and acutely toxic materials are described in the following sections. The specific SDS should always be consulted when doubts arise concerning chemical properties, compatibilities, associated hazards, and storage recommendations. All storage procedures must comply with Cal/OSHA, Fire Code and building code regulations. Figure 3.11 shows the properties to be taken into consideration when developing a storage plan, in order of priority.

Figure 3.11



General Recommendations

Each chemical in the laboratory should be stored in a specific location and returned there after each use. Acceptable chemical storage locations may include corrosive cabinets, flammables cabinets, laboratory shelves, or appropriate refrigerators and freezers. Chemicals should not be routinely stored on laboratory benchtops or on the floor. Fume hoods should not be used as general storage areas for chemicals, as this seriously impairs the ventilating capacity of the hood (Figure 3.12)

Figure 3.12

To avoid overcrowding and unnecessary risk, chemicals should be reviewed periodically, and compromised items removed as chemical waste. Some indications for disposal include:

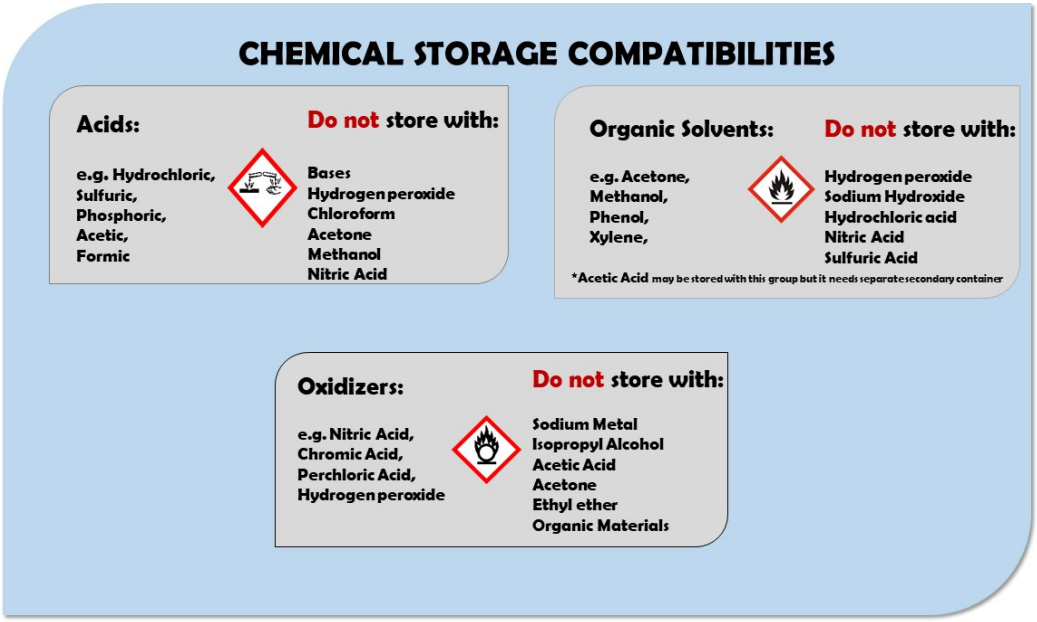
- Cloudiness in liquids
- Color change
- Evidence of liquids in solid material, or solids in liquid material
- 'Puddling' of material around outside of containers
- Obvious deterioration of containers

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

an appropriate temperature and humidity level and should never be stored in direct sunlight or near heat sources, such as laboratory ovens and furnaces.

Incompatible materials should be stored in separate cabinets, whenever possible. If these chemicals must be stored in one cabinet due to space limitations, adequate segregation and secondary containment must be ensured to eliminate the possibility of mixing. Figure 3.13 shows some common chemicals and their storage compatibilities. More detailed information can be found is in Prudent Practices Chapter 5, Section 5.E.2. and Table 5.1. All stored containers and research samples must be appropriately labeled and tightly capped to prevent vapor interactions and to alleviate nuisance odors. Storing chemicals in flasks with cork, rubber or glass stoppers should be avoided due to the potential for leakage.

Figure 3.13



Laboratory refrigerators and freezers must be labeled as "No Food or Drink". Freezers should be defrosted periodically so that chemicals do not become trapped in ice formations.

Flammable and Combustible Liquids

The California Fire Code addresses how much total volume of flammable materials can be stored in a room, floor, or building as a whole. As such, large quantities of flammable or combustible materials should not be stored in the laboratory. No more than **10 gallons** of flammable or combustible liquids, including hazardous waste, are allowed to be kept outside of a flammable storage cabinet, safety can, or approved refrigerator/freezer. The maximum total quantity of NFPA Class 1A flammable liquids within a safety cabinet must not exceed **60 gallons**. These are materials with a flashpoint below 73 °F (22.8 °C) and boiling points below 100 °F (37.8 °C) such as pentane, diethyl ether, etc. The total volume within a cabinet must not exceed **120 gallons** per cabinet.

Figure 3.14

For flammable materials that require low temperature storage, specialized refrigerators or freezers are used. These 'de-sparked' or 'explosion proof' units are specially designed so that no potential source of ignition is present inside the unit (lightbulbs, switches, thermostat knobs, etc.). This is necessary due to the very low flashpoint and high volatility of many flammable liquids. Build-up of fumes inside the unventilated unit, followed by a spark caused by the lightbulb or the compressor turning on is a known cause of multiple laboratory explosions. As standard refrigerators and freezers are also present in the laboratory for non-flammable storage, it is important to be able to distinguish between the two. Figure 3.14 shows the standard warning label placed on all refrigerators that are not suitable for flammable storage. Other identifiers include the presence of lightbulbs, switches and other controls inside the unit. If you are uncertain whether or not a unit is safe for flammable storage, contact EH&S.

Always segregate flammable or combustible liquids from oxidizing acids and oxidizers (e.g. nitric acid). Flammable liquids or gases must never be stored in domestic-type refrigerators/freezers. Flammable or combustible liquids must not be stored on the floor or in any exit access. Handle them only in areas free of ignition sources, and in a fume hood whenever possible. Only the amount of material required for the procedure should be stored in the work area.

Static electricity is a concern when handling flammable and combustible liquids, as a small spark is often sufficient to act as an ignition source. Metal drums must be grounded and bonded during the dispensing process, and a metal pump should be used. Avoid pouring directly from metal drums.

Pyrophoric and Water Reactive Materials

Because pyrophoric substances can spontaneously ignite on contact with air and/or water, they must be handled under an inert atmosphere and in such a way that rigorously excludes air and moisture. Some pyrophoric materials are also toxic and many are dissolved or immersed in a flammable solvent. Other common hazards include corrosivity, teratogenicity, or peroxide formation. **Before working with pyrophoric materials, individuals must demonstrate knowledge of the appropriate methods to handle, transfer, and quench the material being used.**

Only minimal amounts of reactive chemicals should be used in experiments or stored in the laboratory. These chemicals must be stored as recommended in the SDS. Suitable storage locations may include inert gas-filled desiccators, glove boxes, or a flammable substance approved refrigerator/freezer. Reactive material containers must be clearly labeled with the correct chemical name, in English, along with a hazard warning. If pyrophoric or water reactive reagents are received in a specially designed shipping, storage or dispensing container (e.g. Aldrich Sure/Seal™ packaging system) ensure that the integrity of that container is maintained. Ensure that sufficient protective solvent, oil, kerosene, or inert gas remains in the container. Never store reactive chemicals with flammable materials or in a flammable liquid storage cabinet.

Storage of pyrophoric gases is described in the California Fire Code, Chapter 41, and requires gas cabinets with remote sensors and fire suppression. Gas flow, purge and exhaust systems must also have redundant

controls to prevent the pyrophoric gas from igniting or exploding. Emergency back-up power should be provided for all electrical controls, alarms and safeguards associated with the pyrophoric gas storage and process systems. As such, *purchase of pyrophoric gases is restricted and requires EH&S approval via the Gateway purchasing system to ensure the necessary infrastructure is in place before the arrival of the material*.

Oxidizers

Oxidizers such as hydrogen peroxide, halogen gas, potassium permanganate, sodium nitrate, nitric acid, perchloric acid, etc. should be stored in a cool, dry place and kept away from flammable and combustible materials including wood and paper, Styrofoam, plastics, flammable organic chemicals, and away from reducing agents such as zinc, alkali metals, metal hydrides and formic acid.

Vented caps must be used on containers for waste streams of oxidizing inorganic acids or pressure-generating materials (nitric acid, aqua regia piranha etch). These requirements are outlined in the SOP templates for these materials

Peroxide Forming Chemicals (Time-Sensitive Materials)

Peroxide forming chemicals (ethereal solvents, cyclohexene, etc.) should be stored in airtight containers in a dark, cool and dry place and must be segregated from other classes of chemicals that could create a serious hazard to life or property should an accident occur (e.g. acids, bases, oxidizers). All containers should be labeled with the date received and the date opened. This information, along with the chemical identity, should face forward to minimize handling during inspection. Minimize the quantity of peroxide forming chemicals stored in the laboratory and dispose of them before peroxide formation occurs. Refer to the 'Hazard Classes – Peroxide Forming Chemicals' section of this document for information on expiration times for the different classes of peroxide formers. Carefully review all cautionary materials supplied by the manufacturer prior to use. Avoid evaporation or distillation, as distillation defeats the stabilizer added to the solvents. Ensure that containers are tightly sealed to avoid evaporation and that they are free of exterior contamination or crystallization.

Do not handle a container of peroxide forming chemicals if:

- If it greater than five years old, or of undetermined age.
- Crystallization is present in or on the exterior of the container.
- An oily second layer is present in the container.

In this situation, immediately restrict access to the area and contact EH&S.

Potentially Explosive Chemicals

Potentially explosive chemicals such as dibenzoyl peroxide, trinitrobenzene, picric acid and salts, and perchloric acid and salts, should be stored at the manufacturers' recommended temperature in an explosion-proof refrigerator, freezer or cabinet. They should be kept away from heat, light, friction, impact, and any other potential initiating mechanisms. They should be stored away from flammable and combustible materials. Picric acid and perchloric acid should be kept away from metals and metal salts, with which they can react for form highly

explosive products. Picric acid becomes most explosive when dry, and therefore must contain at least 10% water for inhibition. If a bottle of Picric acid of unknown age or condition is found in the lab, isolate the area and contact EH&S. Perchloric acid should be stored by itself, away from all other chemicals.

Corrosives

Store corrosive chemicals (acids, bases) below eye level and in secondary containers that are large enough to contain either 10% of the total volume of liquid stored, or the volume of the largest container, whichever is greater. Acids must be segregated from bases and from active metals such as sodium, potassium and magnesium, as well as from chemicals which could generate toxic gases upon contact such as sodium cyanide and iron sulfide. Additionally, mineral acids must be kept away from organic acids, and oxidizing acids must be segregated from flammable and combustible substances.

Compressed Gases

Compressed gas cylinders must be mounted to a bracket or rack that has been bolted to a structural component of the building, or to casework that is itself bolted to the structure. The cylinder must be held in place by two chains, at 1/3 and at 2/3 height. The safety cap must be in place unless the gas is currently in use (regulator attached). All connections must be inspected frequently. Never used a compressed gas cylinder without a regulator.). For toxic gases, a gas cabinet provides a storage area that is ventilated to the exterior of the building in case of a leak or rupture (Figure 3.15).

Figure 3.15: Gas Cylinder Storage

Even an inert, non-toxic gas like nitrogen poses an asphyxiation risk if the pressure in a nitrogen tank is released suddenly enough to overwhelm room ventilation when present in confined spaces (an elevator or closet) or in poorly ventilated areas (a cold room). Contact EH&S prior to locating cryogenic liquids in these areas to assess if oxygen monitoring is necessary.

For toxic gases, a gas cabinet provides a storage area that is ventilated to the exterior of the building in case of a leak or rupture. Flammable gas cylinders must use only flame-resistant gas lines and hoses, and must have all connections leak-tested. Compressed oxygen gas cylinders must be stored at least 20 feet away from combustible materials and flammable gases, or be separated by a non-combustible partition.

Corrosive gases should be consumed or disposed of within 2 years due to the potential of cylinder failure. This failure can occur via two routes. One is that some acids slowly build up dangerous pressures of hydrogen gas via reaction with the metal cylinder walls resulting in explosion (e.g. HF). The other is the corrosion of the metal components of the cylinder resulting in leaks or frozen valves.

Cryogens

Because cryogenic liquid (e.g. Nitrogen, Argon, Helium, etc.) containers are at low pressure and have protective rings mounted around the regulator, they are not required to be affixed to a permanent fixture such as a wall. However, additional protection considerations should be addressed when storing cryogenic liquids in a laboratory. The primary risk to laboratory personnel from cryogenic liquids is skin or eye damage caused by contact with the material. Always wear eye/face protection and thermally insulated gloves while handling these materials. Additionally, all cryogenic liquids have large expansion volumes, typically greater than 500:1 when transitioning from a cryogenic liquid to a gas at standard temperature and pressure. This volumetric increase can create two types of hazard:

- High pressure: Use only specially designed containers, and ensure that pressure relief valves are functional and unobstructed before use.

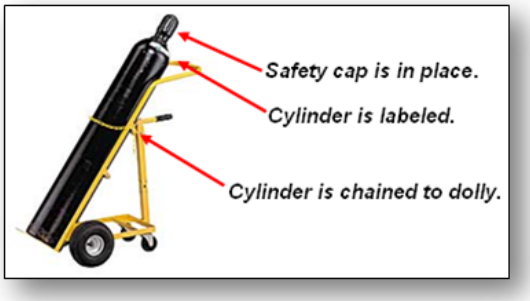
- Oxygen displacement: As is the case for inert compressed gases, while usually non-toxic, there is an asphyxiation risk when cryogenic liquids are present in confined spaces (an elevator or closet) or in poorly ventilated areas (a cold room). Contact EH&S prior to locating cryogenic liquids in these areas to assess if oxygen monitoring is necessary.

Transporting Chemicals

On-Campus Transport of Hazardous Chemicals

Precautions must be taken when transporting substances between laboratories. Chemicals must be transported in break-resistant secondary containers such as commercially available bottle carries that include a carrying handle, or plastic tubs on a sturdy cart with a railing. Chemicals must not be left unattended. Ensure that your destination is accessible before departing.

Figure 3.16



When transporting compressed gas cylinders (Figure 3.16):

- Disconnect regulators and other apparatus prior to transport.
- Always replace the valve safety cap before transporting cylinders.
- Cylinders must always be transported using a hand truck or cart designed for that purpose.
- Transport cylinders upright.

When transporting compressed gases *on elevators*, use service or freight elevators when available. In addition, when transporting compressed gases by elevator:

- Post a sign reading "DO NOT ENTER – GAS TRANSPORT" to exclude passengers. Send the elevator to the desired floor, but do not enter the elevator yourself.
- When possible, have someone send the elevator up while another person waits on the receiving floor to take the cylinder out of the elevator. If this is not possible, another plan should be devised to ensure that the cylinder is taken out of the elevator once it reaches the desired floor.

Off-Campus Transport or Shipment of Hazardous Chemicals

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

Individuals who wish to transport hazardous chemicals or compressed gases off-campus using a UC Santa Barbara or personal vehicle should contact EH&S to ensure safety and compliance. Some information can be found here.

Chemical Security

Access to hazardous chemicals should be restricted at all times. At a minimum, these materials must be stored in laboratories or storerooms that are kept locked when laboratory personnel are not present. Other requirements come into play for chemicals that are of interest to the Drug Enforcement Agency (controlled substances), the Federal Bureau of Investigations (weapons of mass destruction), and the Department of Homeland Security (Chemical Facility Anti-Terrorism Standard 'CFATS' Chemicals of Interest). These requirements are elucidated at the time of acquisition of these materials.

Per Prudent Practices, areas of concern related to laboratory security include:

- Theft or diversion of chemicals, biologicals, and radioactive or proprietary materials.
- Theft or diversion of mission-critical or high-value equipment.

- Threats from activist groups.
- Intentional release of, or exposure to, hazardous materials.
- Sabotage or vandalism of chemicals or high-value equipment.
- Loss or release of sensitive information.
- Rogue work or unauthorized laboratory experimentation.

It is each laboratory's responsibility to report any theft of chemicals from their laboratories to EH&S. Reporting to one or more of the above-listed agencies may be required depending on the nature of the material stolen.

Chemical Exposures: Limits, Assessments, and Medical Evaluations

Regulatory Overview

Under Article 107 of Title 8, Cal/OSHA requires that all employers, "*measure an employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance exceed the action level (or in the absence of an action level, the exposure limit).*" Repeated monitoring may be required if initial monitoring identifies exposures over the action level or the permissible exposure limit.

- *Permissible Exposure Limits (PEL)* are the maximum permitted 8 hour Time Weighted Average (TWA) exposure concentration of an airborne contaminant without the use of respiratory protection.

- *Short-Term Exposure Limits (STEL)* are the maximum permitted 15 minute TWA exposure concentration without the use of respiratory protection.

- *Ceiling Limits (C)* are the exposure concentration of an airborne contaminant that may not be exceeded at any time.

- *Action levels (AL)* are exposure levels at which exposure initiates certain required activities such as exposure monitoring and medical surveillance, and are generally a fraction of the permissible exposure limit.

Cal/OSHA has listed established PELs, STELs and Ceiling limits for chemical contaminants identified in 8 CCR §5155 (Airborne Contaminants) Table AC-1. Cal/OSHA requires that exposures exceeding these levels be controlled in order to prevent harmful health effects. Beyond this list, Cal/OSHA has promulgated specific standards covering several regulated carcinogens, which may include and Action Level (AL), triggering medical surveillance requirements or the imposition of a specific Excursion Limit (such as for asbestos) with a unique measurement of the duration of an exposure.

Exposure Assessments

All UC Santa Barbara employees require protection from exposure to hazardous chemicals above the PELs, STELs and Ceiling limits. In the absence of sufficient engineering controls, an exposure assessment must be conducted in order to ensure exposure limits are not being exceeded. Cal/OSHA requires the person

supervising, directing or evaluating the exposure assessment be competent in the practice of industrial hygiene. Thus, exposure assessments should be performed only by representatives of EH&S.

EH&S utilizes various methods when assessing exposure to hazardous chemicals. These include employee interviews, visual observation of chemical use, evaluation of engineering controls, use of direct reading instrumentation, and the collection of analytical samples from the employee's breathing zone. The assessment will then look at various ways to minimize an exposure, using a combination of elimination, substitution, engineering controls, administrative controls, and person protective equipment, listed in order of priority. Personal exposure assessments may be performed under situations including the following:

1. As determined based on EH&S review of chemical inventories, SOP's, Laboratory Hazard Assessment Tool (LHAT) assessments types of engineering controls present, and/or laboratory safety review outcomes.

2. Concern expressed by a chemical user as to whether exposure is minimized or eliminated through the use of engineering controls or administrative practices. The user should then inform his or her PI/Laboratory Supervisor, who will in turn contact EH&S.

3. A regulatory requirement exists to perform an initial and if warranted periodic monitoring.

If you are concerned about exposures to chemicals or other hazards in your laboratory, please contact your EH&S laboratory safety representative to schedule an exposure assessment. ***In the event of any serious injury or exposure, including chemical splash involving skin or eye contact, call 911 to obtain medical treatment immediately.*** Do not wait for an exposure assessment to be performed before seeking medical care.

Exposure Assessment Protocol

The EH&S Industrial Hygiene Program conducts exposure assessments for members of the campus community. Per Cal/OSHA 8 CCR § 340.1, employees have a right to observe testing, sampling, monitoring or measuring of employee exposure. They are also allowed access to the records and reports related to the exposure assessment. Exposure assessments may be performed for hazardous chemicals, as well as for physical hazards including noise and heat stress, to determine if exposures are within PELs or other appropriate exposure limits. General protocol for conducting an exposure assessment may include any of the following:

1. Employee interviews.

2. Visual observation of chemical usage and/or laboratory operations.

3. Evaluation of simultaneous exposure to multiple chemicals.

4. Evaluation of potential for absorption through the skin, mucus membranes, or eyes.

5. Evaluation of existing engineering controls.

6. Use of direct reading instrumentation.

7. Collection of analytical samples of concentrations of hazardous chemicals taken from the employee's breathing zone, noise dosimetry collected from an employee's shirt collar, or various forms of radiation dosimetry.

If exposure monitoring determines that an employee's exposure is over the Action Level or PEL for a hazard for which Cal/OSHA has developed a specific standard (e.g. lead, methylene chloride), the medical surveillance provisions of that standard shall be followed (see the *Medical Surveillance* section below). If there is no published PEL, STEL or Ceiling limit, EH&S defers to the *Threshold Limit Values (TLV)* established by the American Conference of Governmental Industrial Hygienists (ACGIH), or the *Recommended Exposure Limits (REL)* established by the National Institute of Occupational Safety & Health (NIOSH). It is the responsibility of the PI/Laboratory Supervisor to ensure that nay necessary medical surveillance requirements are met.

Notification of Results

The Industrial Hygiene Program will promptly notify the employee and PI/Laboratory Supervisor of the results of the assessment in writing within 15 days, or less if required by regulation, after the receipt of any exposure monitoring results. The Industrial Hygiene Program will establish and maintain accurate records of any measurements taken to monitor exposures for each employee. Records, including monitoring provided by qualified vendors, will be managed in accordance with Cal/OSHA regulation 8 CCR §3204.

Determination and Implementation of Necessary Controls

When necessary, the results of the assessment will be used by EH&S to determine what control measures are required to reduce the employee's occupational exposure. Particular attention shall be given to the selection of safety control measures for chemicals that are known to be extremely hazardous. Per Cal/OSHA regulation 8 CCR §5141 the control of harmful exposures shall be prevented by implementation of control measures in the following order:

1. Elimination, whenever possible.

2. Substitution, whenever possible.

3. Engineering controls, whenever feasible.

4. Administrative controls, whenever engineering controls are not feasible or do not achieve full compliance, and these administrative controls are practical.

5. Personal Protective Equipment, including respiratory protection
    a. During the time period necessary to install or implement feasible engineering controls.
    b. When engineering controls and administrative controls fail to achieve full compliance.
    c. In emergencies.

Medical Evaluations

All employees, student workers, medical health services volunteers, or laboratory personnel who work with hazardous chemicals shall have an opportunity to receive an employer-provided medical evaluation, including any supplemental examinations that the evaluating physician deems necessary, under the following circumstances:

- Whenever an employee develops signs or symptoms associated with a hazardous chemical to which they may have been exposed at the work area.
- Where personal monitoring indicates exposure to a hazardous chemical is above the Cal/OSHA AL or PEL, or, if these are not established, the TLV or REL as defined in the previous section.
- Whenever an uncontrolled event takes place in the work area such as a spill, leak, explosion, fire, etc., resulting in the likelihood of exposure to a hazardous chemical.
- Upon reasonable request of the employee to discuss medical issues and health concerns regarding work related exposure to hazardous chemicals.

All work-related medical evaluations and examinations will be performed at the Sansum Clinic Occupational Medicine Center by licensed physicians or staff under the supervision of a licensed physician. Evaluations and examinations will be provided without cost to the employee, without loss of pay, and at a reasonable time.

Information to Provide to the Clinician

At the time of the medical evaluation, the following information should be provided by the employee:

1. Employee ID number.
2. Common and/or IUPAC name of the hazardous chemical to which the individual may have been exposed
3. **A copy of the Safety Data Sheet (SDS) of the hazardous chemical in question.**
4. A description of the conditions under which the exposure occurred.
5. Quantitative exposure data, if available (e.g. from exposure monitoring).
6. A description of the signs and symptoms of exposure that the employee is experiencing, if any.
7. A history of exposure, including from previous employment and non-occupational activities.
8. Healthcare providers must be informed of *any* biological materials present in the laboratory.

Physician's Written Opinion

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

1. Recommendations for further follow-up.

2. Results of the medical examination and any associated tests, if requested by the employee.

3. Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous chemical found in the workplace.

4. A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

Confidentiality and Individual's Access to Personal Medical Records

All patient medical information is protected by both California and Federal lab, and is considered strictly confidential. Sansum Clinic is prohibited from disclosing any patient medical information that is not directly related to the work-related exposure under evaluation, and will not reveal any diagnosis unrelated to the work-related exposure.

- Any patient information disclosed by Sansum Clinic to the employee's supervisor will be limited to information necessary in assessing an employee's return to work, including recommended restrictions in work activities, if any.

- Any patient information disclosed by Sansum Clinic to EH&S will be limited to information necessary to develop a course of exposure monitoring, or perform hazard assessments and incident investigations, if appropriate.

Sansum Clinic will otherwise disclose patient medical information only as required by California and Federal law, such as for Worker's Compensation Insurance claims**.** *However, each employee has the right to access his/her own personal medical and exposure records*. Sansum Clinic will provide an employee with a copy of his/her medical records upon written request.

Medical Surveillance

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

Medical Surveillance is required of employees who are routinely exposed to certain hazards as part of their job description (such as asbestos) and may be offered to other employees based upon quantifiable or measured exposure.

Examples of hazards that are monitored through the medical surveillance program include:

- Asbestos
- Berylium
- Noise (Hearing Conservation Program)
- Radioactive Materials (Bioassay Program)

- Formaldehyde
- Lead
- Methylene Chloride
- Respirator Use
- Other Particularly Hazardous Substances

Hazardous Chemical Waste Management

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

UC Santa Barbara Hazardous Waste Program

The Hazardous Waste Program is responsible for providing cost-effective hazardous waste management in compliance with federal state, and local regulations. It provides waste pickup, emergency spill response and assistance with shipping hazardous materials. Additionally, it is responsible for pollution prevention, regulatory reporting, and maintaining campus emergency response capabilities. Each laboratory user must comply with the UCSB hazardous waste disposal procedures to ensure that all regulatory requirements are being met. Regularly scheduled waste pick-up service is in place for large volume generators in most buildings with wet labs, however, pick-ups are also available upon request in those buildings as well as those without scheduled pick-ups. Laboratory personnel are responsible for identifying waste, labeling it, and storing it properly in the laboratory. Laboratory clean-outs/decommissioning and disposal of high hazard compounds (expired peroxide formers, dried picric acid, abandoned unknown chemicals, etc.) must be scheduled in advance.

Definition of Hazardous Waste

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

- *Corrosive*: pH ≤ 2 or ≥12.5
- *Ignitable*: Liquids with a flash point below 60 °C or 140 °F.

- *Reactive*: unstable, explosive, reacts violently with air and/or water, or releases a toxic gas when in contact with water.

- *Toxic*: As determined by toxicity testing.

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

- Abandoned chemicals.

- Unused or unwanted chemicals.

- Chemicals in compromised containers (ruptured, punctured, corroded, etc.)

- Empty containers that have visible residues.

- Containers with conflicting labeling (dual labeling).

- Unlabeled or unknown chemicals.

Chemicals not in frequent use must be carefully managed to prevent them from being considered a hazardous waste. This is especially true for certain compounds that degrade and destabilize over time and require careful management so that they do not become a safety hazard, as described in the section below entitled 'Waste that Requires Special Handling'.

Extremely Hazardous Waste

Certain compounds meet an additional definition known as 'extremely hazardous waste'. This list of compounds includes carcinogens, pesticides, and reactive compounds, among others. Some examples include cyanides, sodium azide, and hydrofluoric acid. The Federal EPA refers to this waste as 'acutely hazardous waste, but Cal/EPA has published a more detailed list of extremely hazardous waste. Both the state and federal lists are included in the EH&S List of Extremely Hazardous Waste. Note: This list, although having some overlap, should not be confused with the list of Particularly Hazardous Substances previously addressed in this document.

Proper Hazardous Waste Management

Training

All personnel who are responsible for handling, managing or disposing of hazardous waste must complete training. Hazardous Chemical Waste training is a component of the Fundamentals of Laboratory Safety course offered by EH&S both live and online. This satisfies the training requirement. However, if further training is desired, there is an additional online UCSB Hazardous Waste Generator training available through the learning center as well.

Waste Identification

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

For commercial mixtures, the manufacturer's SDS provides detailed information on each hazardous ingredient present, and also the chemical, physical, and toxicological properties of the ingredient. The UCSB EH&S website provides access to SDS's for hazardous chemicals.

Labeling

Every container must be appropriately labeled per hazardous waste program requirements. These include:

- Use the official campus hazardous waste label and provide all necessary information.
- All hazardous waste containers must be labeled with the words 'Hazardous Waste'.
- All unknowns must be analyzed and their hazardous components identified at the generator's expense. Do not lose track of container contents!
- Waste must be identified by chemical name in English. Labels such as 'Inorganic Waste' and 'Organic Waste' are not adequate. Do not use abbreviations, acronyms, or chemical formulas.
- All constituents in solid and liquid mixtures must be identified, and to the extent possible their concentrations stated.
- The chemical hazard class of the waste must be identified (e.g. flammable, corrosive, oxidizer, etc.)
- Any preexisting labels on the container must be defaced either by removal or by crossing out the information.
- *All containers must be dated with the date on which waste was first stored in the container*. Under no circumstances store hazardous waste in the laboratory for more than 270 days (about 9 months).

Storage

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

- Waste must be collected and stored at or near the point of generation.

- According to state law, the maximum amount of waste that can be stored in an SAA is 55 gallons of hazardous waste or 1 quart of extremely hazardous waste. If these volumes are met, the waste must be disposed of within 3 days.

- According to the California Fire Code, the maximum amount of flammable solvents allowed to be stored in a laboratory outside a flammable storage cabinet is 10 gallons. *This figure includes accumulated waste*.

- All waste containers must be kept closed when not in use. Containers should be designed so they can be completely sealed when not in use (no open-top glassware).

- Waste containers must be appropriate for the waste being stored in it. (e.g. do not use a glass container for hydrofluoric acid waste), and the waste streams segregated into compatible constituents.

- Oxidizing inorganic wastes (e.g. nitric acid, chromic acid, perchloric acid) or pressure generating wastes (e.g. piranha etch, aqua regia) must be stored with vented caps (contact EH&S for free vented caps).

- Liquid waste should be in screw top containers, and not be filled over 80%. Secondary containment should be used at all times.

- Outside surfaces of containers must be clean and free of contamination.

- Gas cylinders and lecture bottles must have regulators removed.

- Sharps must be stored in puncture-proof containers.

- Store containers in a designated location (low traffic, safe, secure, contained, etc.). Label this storage area as 'Hazardous Waste Storage Area'.

Segregation

All hazardous waste must be managed in a manner that prevents spills and unexpected reactions. Additionally, proper waste segregation can help reduce disposal costs. Proper segregation procedure includes:

- Segregate solids, liquids and gases.

- Further segregate into the following categories:
    - Halogenated Organics
    - Non-halogenated Organics
    - Strong oxidizers
    - Peroxide formers

o	Acids of pH $\leq$ 2	o	Cyanides
o	Bases of pH $\geq$ 12.5	o	Chemical Carcinogens
o	Alkali metals/other water reactive	o	Unstable chemicals
o	Heavy metal solutions & salts	o	Other toxic materials

Incompatible Waste Streams

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

A common incompatible waste stream is the addition of nitric acid to a waste container containing organic solvent. This creates a very exothermic reaction and cause catastrophic container failure/large explosion. Extreme care should be taken with nitric acid waste. Store in dedicated small waste bottles, label them clearly, and dispose of them quickly.

Waste Which Requires Special Handling

Sharps and Laboratory Glass Waste

Sharps waste includes any device having acute rigid corners, edges, or protuberances capable of cutting or piercing, including but not limited to hypodermic needles, syringes, razor blades and scalpel blades. Glass items contaminated with biohazards, such as pipettes, microscope slides and capillary tubes are also considered sharps waste. Under no circumstances may sharps waste be disposed of in the normal trash. Sharps waste containers must be rigid, puncture-resistant, lidded and leak-proof when sealed.

Laboratory glass is defined as equipment made of Pyrex, borosilicate, and quarts glass used for scientific experiments. Examples of laboratory glass include beakers, flasks, graduated cylinders, stirring rods, test tubes, microscope slides, glass pipettes, petri dishes and glass vials. This waste should be disposed of in a cardboard lab glass box. *All glassware must be free of pourable liquid and must not contain sludges or caked solids. Glass items contaminated with biohazards are considered sharps waste (see paragraph above)*.

Further details on how to manage sharps and lab glass waste can be found in the EH&S Laboratory Sharps Fact Sheet.

Peroxide Forming Chemicals

Ensure containers of peroxide forming chemicals are kept tightly sealed to avoid unnecessary evaporation, as this inhibits the stabilizers that are sometimes added. Visually inspect containers periodically to ensure they are free of exterior contamination or crystallization. *Dispose of containers of peroxide forming chemicals before their expiration date*.

If old containers of peroxide forming chemicals are discovered in the laboratory (greater than five years past the expiration date or if the expiration date is unknown), **do not handle the container**. If crystallization is present in or on the container, **do not handle the container**. *Secure the area and contact EH&S immediately*.

Picric acid (trinitrophenol) must be kept hydrated at all times, as it becomes increasingly unstable as it loses water content. **When dehydrated it is explosive and sensitive to shock, heat, and friction**. It is also highly reactive with a variety of compounds. All picric acid containers should be dated with the date received, and the water content monitored every 6 months. Add distilled water as needed to maintain a consistent liquid volume.

If old containers or containers of unknown provenance are discovered, **do not touch the container**. Even a minor disturbance could be very dangerous. Visually inspect the bottle. If there is even the slightest sign of crystallization in or on the bottle, or of evaporation, *secure the area and contact EH&S immediately*.

Explosives and other Compounds with Shipping Restrictions

A variety of compounds that are classified as explosives (e.g. many nitro- and azo-compounds) or are water or air reactive are used in research laboratories. These compounds often have shipping restrictions and special packaging requirements, and may require stabilization prior to disposal. Consult with the Chemical Hygiene Officer for disposal considerations for these compounds.

Controlled Substances

Waste containing intact controlled substances (e.g. expired ketamine) must be disposed of by DEA approved means. Contact the UCSB Controlled Substances Program for guidance.

Empty Containers

Empty containers that held extremely hazardous materials, including extremely hazardous waste must be disposed of through EH&S, as these containers are regulated as hazardous waste. All other containers of less than or equal to 5 gallons should be reused for hazardous waste collection, recycled or disposed of. For more details, see the EH&S Empty Containers Fact Sheet.

Hazardous Waste Minimization

The UC Santa Barbara Hazardous Waste Minimization Program has the goal of reducing the amount and toxicity of waste generated through university activities. In addition to reducing risk to human health and the environment, waste minimization offers cost benefits in the form of avoided chemical purchasing and disposal costs. Some approaches to waste minimization include:

Source Reduction

Changing practices and processes in order to reduce or eliminate the generation of hazardous waste is the best approach to waste minimization. This approach can include:

- Effective Purchasing: Order smaller volumes to avoid chemical expiration/degradation. Maintain an accurate chemical inventory to avoid duplicate orders.

- Good Housekeeping: Use a 'first in-first out' system in which the oldest chemicals are used first, to keep chemical stocks rotated.

- Chemical Substitution: Evaluate processes to determine whether a less hazardous chemical can be used in place of a more hazardous option.

- Scale Reduction: Reduce total volumes in experiments; employ microscale techniques where possible. Use instrumental analytical methods rather than wet chemical techniques.

Recycling and Bench Top Treatment

When source reduction is not possible, recycling is the next best approach to waste minimization. Recycling of waste can take place both on and off campus and can include using a waste material for another purpose, treating a waste material and using it in the same process, or reclaiming a waste material for another process. Some examples include:

- Repurifying used solvents.

- Recirculating unused or surplus chemicals within your department or through the UCSB Surplus Chemicals program.

- Shipment of flammable liquid waste to offsite facilities, such as cement kilns, to be used as supplemental fuels.

Some waste can be treated to render it less or non-hazardous. Some examples include:

- Neutralizing acids and bases.

- Polymerizing acrylamide solutions.

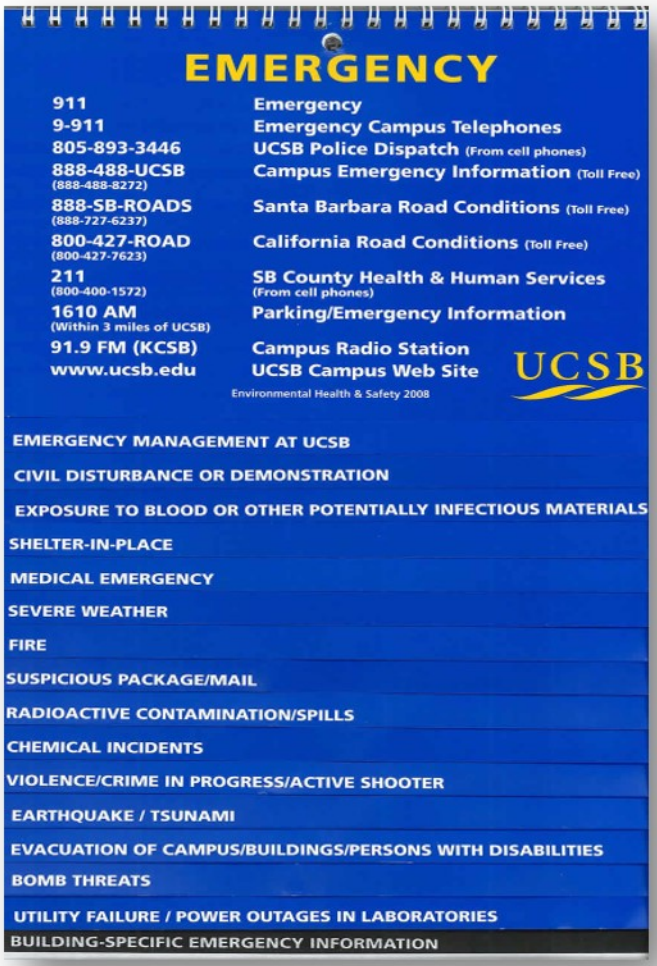
- Oxidizing cyanide salts with bleach solutions.

- Charcoal filtration of ethidium bromide solutions.

Note: if treatment is not part of the end step of an experiment and is done separately from the experiment, it is considered hazardous waste treatment. This treatment activity requires a California Tiered Permit unless the activities comply with Health and Safety Code 2200.3.1. As such, please contact EH&S if you plan to conduct any bench-top treatment of waste.

Chapter 4: Emergencies

Laboratory emergencies include events such as serious injuries, fires, explosions, spills, hazard exposures and natural disasters. All laboratory employees should be familiar with and aware of the location of the blue UCSB Emergency Flip Chart. This document has detailed response information for a wide variety of emergency situations. There should be one flip chart in every laboratory room or bay. Contact EH&S if additional copies of this document are needed. Before beginning any laboratory operation, ensure that there is a plan in place to deal with any potential emergency situations. Identify the location of safety equipment including first aid kits, eye wash/safety shower units, fire extinguishers, fire alarm pull stations, and spill kits. Know the locations of the nearest exits and telephones. See the following sections for more guidance on when an emergency response is warranted. However, *when in doubt, treat the situation as an emergency*.



If during an emergency or response, an unknown or hazardous chemical exposure occurs, an exposure assessment may be necessary. All applicable exposure assessment protocols will therefore be activated at that time.

Accidents

TREATMENT:

LABORATORY INJURY OR EXPOSURE

EMPLOYEES *(Getting paid by UC at time of incident)*	STUDENTS *(Getting paid by UC at time of incident)*	EVERYONE ELSE
Sansum Clinic Occupational Medicine (805) 898-3311 101 S Patterson Ave Weekdays 8 am to 5 pm	**Student Health** (805) 893-7129 or (805) 893-3371 Located on El Colegio and Mesa Rds., across from the Events Center. Weekdays 9 am to 4:30 pm	**Go to your personal medical provider**

AFTER HOURS AND IMMEDIATE TREATMENT FOR EVERYONE

URGENT CARE	Goleta Valley Cottage Hospital	Santa Barbara Cottage Hospital
(805) 563-6110 Sansum Clinic, 215 Pesetas Lane Monday - Friday, 8:00am - 7:00pm Saturday, 9:00am - 5:00pm Sunday, 9:00am - 3:00 pm (USE ONLY WHEN PATTERSON OFFICE IS CLOSED)	(805) 967-3411 351 S. Patterson Ave Open 24 hours (USE FOR EMERGENCIES)	(805) 682-7111 Pueblo at Bath Open 24 hours (USE FOR EMERGENCIES)

NOTICES

Explain Exposure: Be prepared to communicate exposure details (e.g., chemical name, biohazard) to medical providers.
Transportation: Arrange an escort when possible. For non-emergencies, you may use a personal vehicle instead of taking an ambulance.
Report: Work related injury/illness claims should be filed as soon as possible at ehs.ucop.edu/efr
For students fill out Notice of Incident Form available at https://www.ehs.ucsb.edu/
Near miss report form available at https://www.ehs.ucsb.edu/

CALL 911 IF EMERGENCY OR LIFE THREATENING

- Laboratory employees who are injured or ill should notify their PI/Laboratory Supervisor immediately, and then seek medical attention if needed. **When in doubt, seek medical attention**.

- Each laboratory should prepare for emergencies by, at minimum:
  - Access to a first aid kit.

  - Posting of emergency telephone numbers and locations of emergency treatment facilities and occupational health facilities.

  - Training of staff to:
    - Assist injured personnel with the emergency eyewash/shower and ensure that they flush exposed areas for a full 15 minutes.

- Accompany injured personnel to the medical treatment site and to provide medical personnel with copies of Safety Data Sheets (SDS) for the chemicals involved in the incident.

If an employee has a severe or life threatening injury, call for emergency response. Employees with minor injuries should be treated with first aid kits and sent to Sansum Clinic Occupational Medicine. If the lab worker is a student (i.e. not on UCSB payroll), then they should go to Student Health for service. After normal business hours, treatment can be obtained at Goleta Valley or Santa Barbara Cottage Hospital.

REPORTING:

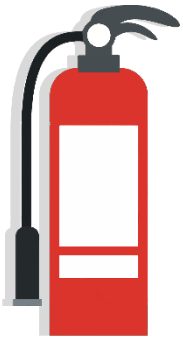
- PIs/Laboratory Supervisors are responsible for ensuring that their employees receive appropriate medical attention in the event of an occupational injury or illness. The PI/Laboratory Supervisor should call Workers' Compensation (805-893-4440) immediately if an employee seeks medical treatment, followed by creating a claim through the Employee First Report (EFR) system.

- **Serious occupational injuries, illnesses, and exposures to hazardous substances must be reported to EH&S at 805-893-3194 within 8 hours.** EH&S is required to report these events to Cal/OSHA, and will also investigate the accident and complete exposure monitoring as necessary. Serious injuries are defined as those that result in permanent impairment or disfigurement, or require hospitalization. Examples include amputations, lacerations with severe bleeding, burns, concussions, fractures and crush injuries.

Laboratory Safety Equipment

New personnel must be instructed in the location and use of fire extinguishers, safety showers, and other safety equipment *before* they begin work in the laboratory. This training is part of the required laboratory specific training that is documented on the Training Needs Assessment Form. Hands-on fire extinguisher training is provided during the live Fundamentals of Laboratory Safety course, as well as upon request.

Fire Extinguishers



All laboratories working with combustible or flammable chemicals must be outfitted with appropriate fire extinguishers. All extinguishers should be wall-mounted in an area free of clutter, or stored in a fire extinguisher cabinet. Research personnel should be familiar with the location, use and classification of the extinguishers in their laboratory. Laboratory personnel are *not required* to extinguish fires that occur in their work areas and should not attempt to do so unless:

- It is a small fire (small trash can-sized or smaller).

- Hands-on fire extinguisher training has been received.

- It is safe to do so.

- The individual wishes to do so.

Any time a fire extinguisher is discharged, no matter what the reason or how brief a period, EH&S must be contacted. Once partially discharged, an extinguisher will lose pressure quickly and therefore must be replaced as soon as possible.

Safety Shower/Eyewash Stations

All laboratories using hazardous chemicals must have immediate access to safety shower/eyewash stations. Access must be available in 10 seconds or less for a potentially injured individual, and access routes must have no more than one intervening door, opening in the direction of travel, and must be kept clear at all times. Safety showers require a minimum clearance of 16 inches from the centerline of the spray pattern in all directions and at all times. *Therefore, no objects should be stored within 16 inches of a safety shower*. Sink-based eyewash stations and drench hoses are not adequate to meet this requirement and can only be used to support an existing compliant system.

In the event of an emergency, individuals using the safety shower should be assisted by an uninjured person to aid in decontamination, and should be encouraged to stay in the shower for a full 15 minutes.

Safety shower/eyewash stations are tested by Facilities Management on a monthly basis. If a safety shower/eyewash unit appears to need repair, call Facilities Management Customer Service at 805-893-8300.

Fire Doors

Research buildings contain critical fire doors as part of the building design. As an important element of the building fire containment system, these doors shall remain closed unless they are held open by an electromagnetic releasing system integrated with the building fire detection system. Never use door stops to hold fire doors open.

Fire-Related Emergencies

If you encounter a fire, or a fire-related emergency (e.g. abno0rmal heating, smoke, burning odor), immediately follow these instructions:

- Pull the closest fire alarm pull station and call 911 to notify the Fire Department.
- Evacuate and isolate the area. Close all doors. Shut off equipment if feasible.
- Remain safely outside the affected area to provide details to emergency responders (do not leave).

If you hear a fire alarm sound, evacuate the building. *It is against state law to remain in the building when the alarm is sounding*, even if it is a false alarm or drill. Do not reenter the building until the alarm stops and you are cleared to reenter by Fire Department personnel.

If your clothing catches fire, go to the nearest emergency shower and activate the water flow. If the shower is more than 3 steps away, Stop, Drop and Roll, then proceed to the nearest shower to cool off. A fire extinguisher may be used to extinguish a fire on someone's person. Report any burn injury to your supervisor immediately and seek medical treatment.

Chemical Spills

For all spill releases occurring during regular work hours (8:00am-5:00pm), notify EH&S at (805)893-3194 immediately, regardless of whether you require clean-up assistance. **After hours, if the spill is not easily contained, or if you are concerned about the health and safety of yourself and others, call 911.** Otherwise notify EH&S at (805)893-3194 as described above.

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

- The spill results in injury and/or a release to the environment (e.g. via a sink or floor drain).

- The material or its hazards are unknown.

- Laboratory personnel cannot safely manage the situation due to high hazard or volumes greater than one liter.

Effective response to chemical spills is necessary to minimize adverse outcomes such as injury, illness, or environmental damage. After emergency procedures are completed, all personnel involved in the incident should follow UCSB chemical exposure procedures as appropriate (see Chemical Exposures: Limits, Assessments, and Medical Evaluations in Chapter 3 of this document). Some key factors to consider before initiating a spill clean-up include:

- Location
- Volume/size of spill area
- Toxicity
- Volatility
- Flammability and presence of ignition sources
- Availability of spill cleanup materials, including proper PPE
- Training of responders

NOTE: HIGHLY HAZARDOUS CHEMICAL SPILLS
Do not clean up spills of any size of the following chemicals:

- **Aromatic amines**
- **Carbon disulfide**
- **Cyanides**
- **Ethers**
- **Mercury**
- **Hydrazine**
- **Hydrofluoric acid**
- **Nitriles**
- **Nitro compounds**
- **Organic halides**

Spills of these chemicals require emergency response.
Evacuate, isolate the area and contact EH&S.

Small Chemical Spill Procedure (< 1 Liter)

If a spill is up to 1 liter in size and of limited toxicity, flammability and volatility, laboratory members may choose to effect clean-up if trained to do. EH&S may be called for spills of < 1 liter. If laboratory personnel choose to clean the spill, the following procedure should be followed:

- Evacuate all non-essential persons from the spill area.

- If needed, call for medical assistance by calling 911.

- Help anyone who may have been contaminated. Assist with shower/eyewash as needed.

- Post someone just outside of the spill area to keep people from entering.

- Turn off all ignitions sources, and close valves on compressed gas cylinders of flammable gas.

- Don proper PPE: Safety goggles, laboratory coat, shoe covers and appropriate gloves at minimum. Check the SDS for spill clean-up procedures including necessary PPE or call EH&S.

- Avoid breathing vapors from the spill. If the spill is in a non-ventilated area, do not attempt the clean-up. Evacuate, isolate the area and call EH&S.

- Confine the spill to as small an area as possible by treating it from the outside edges in.

- Do not clean up the spill alone. Use the buddy system.

- Do not add water to the spill.

- To clean up a spill of weak inorganic acid or base, neutralized the spilled liquid to pH = 5-8 us in a neutralizing agent such as sodium bicarbonate, sodium bisulfate, or soda ash for spilled acids, or citric acid for spilled bases. For solvent spills skip to the next step.

- Absorb the neutralized liquid or solvent with an absorbent such as sorbent pads, sponges, paper towels, dry sand or diatomaceous earth.

- Collect the absorbents and place in a clear plastic bag. Double bag the waste and attach a completed hazardous waste label to the bag. Transport to the waste pickup area and schedule a pickup.

Large Chemical Spill Procedure (> 1 Liter)

If the spill presents a situation that is immediately dangerous to life or health or presents a significant fire risk, activate a fire alarm, evacuate the area, call 911 and wait for emergency response to arrive. Otherwise

- Remove any injured and/or contaminated person(s) and provide first aid.

- Call for emergency medical response if needed.

- As you evacuate the laboratory, close the door behind you, and:

    - Post someone safely outside and away from the spill area to keep people from entering.
    - Confine the spill area if possible and safe to do so.
    - Leave on or establish exhaust ventilation
    - If possible, if the material is flammable, turn off or remove all ignition sources.
    - Avoid walking through contaminated areas or breathing vapors of the spilled materials.
- Any employee with known contact with a particularly hazardous chemical must shower, including washing of hair, as soon as possible unless contraindicated by physical injuries.

Chemical Exposure to Personnel

In the event of a significant chemical exposure:

- immediately try to remove or isolate the chemical if safe to do so.
- When skin or eye exposures occur, remove contaminated clothing and flush the affected area using an eyewash/shower unit *for at least 15 minutes*.
- Remember to wear appropriate PPE when helping others.
- For a non-emergency chemical ingestion, inhalation or dermal exposure contact the California Poison Control System at 1-800-222-1222 for assistance, and seek medical care as instructed.

PIs/Laboratory Supervisors must review all exposure situations, make sure affected employees receive appropriate medical treatment and/or assessment, and arrange for containment and clean-up of the chemical as appropriate (either by laboratory personnel or by contacting EH&S).

Earthquake

In the event of an earthquake, please take the following precautions:

- Prepare in advance: be familiar with your department's Emergency Action Plan.
- Take cover under a desk or strong doorframe during the shaking.
- Remain under cover indoors until the shaking subsides. Evacuate the building only once the shaking has ceased. Proceed to your building's emergency assembly point.
- Report any injuries or broken utility services to 911.
- Assist any injured individuals with receiving medical attention.

Chapter 5: Compliance

Recordkeeping Requirements

Accurate recordkeeping demonstrates a commitment to the health and safety of the UC Santa Barbara community, integrity of research, and protection of the environment. EH&S is responsible for maintaining records of the Laboratory Safety Reviews, all laboratory audits and surveys, accident investigations, monitoring equipment calibration and exposure assessment data, inventory and use records for high-hazard materials, any medical consultation and examination records, including test or written opinions, and training conducted by EH&S staff or on line. Per Cal/OSHA regulations, departments or laboratories are responsible for documenting departmental or lab specific health and safety training. The Training Needs Assessment Form is a useful tool for documenting each person's training record.

Notification and Accountability

PI's/Laboratory Supervisors are responsible for taking appropriate and effective corrective action upon receipt of written notification of findings requiring resolution that are identified via lab safety reviews, audits, surveys or inspections. Findings are assigned one of four priority levels, each with its own timeframe for resolution:

> **Imminent Danger** (Immediate danger to life and health, significant property damage, serious near-miss incidents involving conditions that are likely present in other locations on campus.): Immediate Resolution/Stop Work.
>
> **Priority One** (Serious safety hazard, serious/willful regulatory violations and/or significant fire and life safety code violation): Closure within 0-5 days
>
> **Priority Two** (Moderate safety hazard or moderate/repeat regulatory violation and/or moderate fire and life safety concern/housekeeping/documentation issues, etc.): Closure within 6-30 days
>
> **Priority Three:** Closure within 31-90 days (minimal safety hazard/ possible regulatory violation, infrastructure, deferred maintenance, etc.)

The determination of prioritization is subjective based on the inspector's judgment. Every situation is unique; EHS inspectors will base inspection findings on a review of relevant hazards, codes and exposures.

Compliance Procedures

Reminder emails will be sent to the PI/Laboratory Supervisor after the initial report is sent. Repeat issue of non-compliance, identified via scheduled inspection or otherwise, include but are not limited to:

- Any Serious (Priority 2) findings that have not been corrected within 30 calendar days of the initial report of non-compliance.
- Any urgent (Priority 1) findings that have not been corrected within 5 days of the initial report on non-compliance.

When the above conditions are met, the following escalation protocols are initiated:

Priority 2 (Serious) Escalation Protocol

Escalation 1: Email notification sent to Department Chair at 4 weeks:

Dear Prof. [ ],

This letter is to inform you that Prof. [ ] has outstanding serious findings in the most recent Environmental Health and Safety laboratory inspection. Our standard practice for serious findings is to remind the responsible party to correct the findings and update the INSPECT database twice, in two week intervals, before escalating the issue to the department chair. That period has now expired.

Please remind Prof [ ] that addressing safety issues and documenting corrections is a key part of sustaining a safe and compliant laboratory culture, and request that they complete the corrections and update the INSPECT database as soon as possible.

Thank you,

Escalation 2: Email to Department Chair at 6 weeks:

Dear Prof. [ ],

This letter is to inform you that Prof. [ ] still has outstanding serious findings in the most recent Environmental Health and Safety laboratory inspection. This is our second notification to you regarding this issue. Our standard practice in this situation is to send a second notification to the department chair, followed by escalation to the Dean if the matter is not resolved within two weeks of this notice.

Please remind Prof [ ] that addressing safety issues and documenting corrections is a key part of sustaining a safe and compliant laboratory culture, and request that they complete the corrections and update the INSPECT database as soon as possible.

Thank you,

Escalation 3: Email to Dean at 8 weeks:

Dear Dean [ ],

This letter is to inform you that Prof. [ ] has outstanding serious findings in the most recent Environmental Health and Safety laboratory inspection. Our standard practice for serious findings is to remind the responsible party to correct the findings and update the INSPECT database twice, in two week intervals, before escalating the issue to the department chair. As the matter is still not resolved upon contacting the department chair, we are reaching out to you for assistance in getting this matter resolved.

Please remind Prof [ ] that addressing safety issues and documenting corrections is a key part of sustaining a safe and compliant laboratory culture, and request that they complete the corrections and update the INSPECT database as soon as possible.

Thank you

Escalation 4: Refer the issue to the Chemical and Physical Hazard Safety Committee.

Priority 1 (Urgent)

Escalation 1: Email to Department Chair at 5 days:

Dear Prof. [ ],

This letter is to inform you that Prof. [ ] has outstanding urgent findings in the most recent Environmental Health and Safety laboratory inspection. Our standard practice for urgent findings is to remind the responsible party to correct the findings and update the INSPECT database once, five days after the initial notification, before escalating the issue to the department chair. That period has now expired.

Please remind Prof [ ] that addressing safety issues and documenting corrections is a key part of sustaining a safe and compliant laboratory culture, and request that they complete the corrections and update the INSPECT database as soon as possible. The matter will be escalated to the Dean if the matter is not resolved within two days of this notice.

Thank you,

Escalation 2: Email to Dean at 7 days:

Dear Dean [ ],

This letter is to inform you that Prof. Y has outstanding urgent findings in the most recent Environmental Health and Safety laboratory inspection. Our standard practice for urgent findings is to remind the responsible party to correct the findings and update the INSPECT database five days after the initial notification, before escalating the issue to the department chair. As the matter is still not resolved upon contacting the department chair, we are reaching out to you for assistance in getting this matter resolved.

Please remind Prof [ ] that addressing safety issues and documenting corrections is a key part of sustaining a safe and compliant laboratory culture, and request that they complete the corrections and update the INSPECT database as soon as possible.

Thank you,

Escalation 3: Refer the issue to the Chemical and Physical Hazard Safety Committee.

Acknowledgements

UC Santa Barbara would like to thank the UCLA Office of Environmental Health & Safety. This document was created using the UCLA Chemical Hygiene Plan 2019 as a major source of content.

This document was reviewed, edited and approved by the UC Santa Barbara Chemical and Physical Hazards Safety Committee, Prof. Christopher Palmstrøm, Chair.

Section III: Appendix

Publication date November 8, 2021

UC SANTA BARBARA

CHEMICAL HYGIENE PLAN

Appendix

Laboratory Supervisor and Principal Investigator Responsibilities 2

Research Safety Self-Inspection Checklist 7

GHS Classification System 8

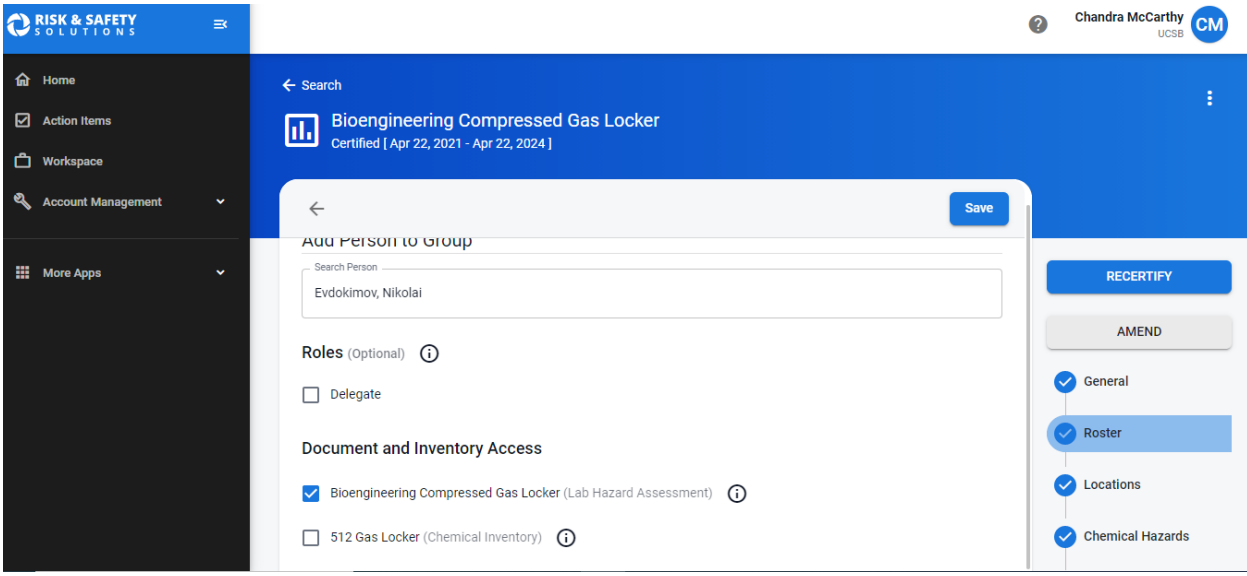
Combined List of Particularly Hazardous Substances (PHS) 23

Laboratory Supervisor and Principal Investigator Responsibilities

(For new PIs)

1. **Fundamentals of Laboratory Safety:** Please ensure all lab workers have taken either the live or online version of the course before they begin work in the laboratory.

2. **Create a Laboratory Hazard Assessment:**
   - Login to Assessment (LHAT) using your campus credentials.
   - From the RSS Home Page, click ***Begin A Laboratory Hazard Assessment***
   - Follow the prompts and click ***Certify***
   - Once certified, you may add lab members to your **Roster** by clicking on "Roster" from the right side menu, then click on the plus icon to the bottom right. Type the last name of the new member in the search *for person* window until the name & email populates(click on the populated name/email), you will see something like this:



   Click **Save** to add the member. (Note, before you click Save, you will have the option to assign the member as a delegate and/or a UC Chemical Inventory member, by checking the appropriate box).

- Upon adding a new member to the roster, the lab Member will receive an email notification requiring them to acknowledge the assessment and complete the PPE training & quiz. Once the PPE training/quiz is completed (next Steps), the member will schedule an appointment via the PPE Google Calendar to pick up their free PPE (2 lab coats & eyewear). For more information regarding PPE refer to the Laboratory Personal Protective Equipment section of the EH&S website.

3. **Training Needs Assessment form:** Please ensure lab workers have completed a Training Needs Assessment. Retain a copy of the completed, signed and dated TNA form for documentation (e.g. keep copies in the Chemical Hygiene Plan binder or similar).

4. **Laboratory-Specific Chemical Hygiene Plan:** PI/Supervisors are required to maintain a copy of their Chemical Hygiene Plan. EH&S will provide you with a binder, which includes three sections. Section I is lab specific and should include Standard Operating Procedures(SOPs) for safe work with hazardous materials and/or processes. You may print the CHP from our website (click on hyperlink above). Ensure the lab worker has reviewed sections I&II of your lab's Chemical Hygiene Plan and signed the Laboratory Worker Training Record found in Section I. Ensure you have the latest version of Sections II & III of the CHP and that you have created/added/and-or updated the SOPs in your CHP. You may use Standard Operating Procedure templates located in the EH&S website. To view the policy regarding CHP go to http://www.ehs.ucsb.edu/labsafety-chp

5. **OSHA's Occupational Exposure Limits:** Please refer to the Industrial Hygiene section of the EH&S website regarding occupational exposure limits.

6. **Authorization Coordinated by EH&S:**
   - The Institutional Biosafety Committee reviews and approves work with human tissues, infectious agents - Contact Jamie Bishop. For more information and resources regarding Biological Safety visit: https://www.ehs.ucsb.edu/biosafety

- The Dive Safety Committee reviews and approves work out in the open ocean - Contact Eric Hessell. For more information and resources regarding Dive & Boat Safety visit: https://www.ehs.ucsb.edu/dive
- The EH&S controlled substance coordinator assists with DEA licenses for work with Schedule I - Contact Derek Iverson.
- The Radiation Safety officer maintains inventory of all class 3b and 4 laser systems - Contact Robert Brown. For more information and resources regarding Radiation Safety visit: https://www.ehs.ucsb.edu/rad
- The Research & Occupational Specialist approves Chemical Storage Units - Contact Hector Acuna
- Respiratory Protection Program - For the use of face masks or dust masks, please contact Jesse Bickley jesse.bickley@ucsb.edu or Nick Nieberding nick.nieberding@ucsb.edu

7. **Safety Data Sheets:** Please review OSHA's requirements for maintaining SDSs in the work area and training laboratory workers on how to use SDSs.

8. **Fire & Door Placard, Incidents & Near Miss reporting, and UC Chemicals:**
   - Please maintain an Emergency Flip Chart in the lab(s). You may arrange to pick one up from EH&S (contact Chandra Mccarthy). Ensure the Building-Specific Emergency Information is completed and posted. Additionally we are required to post door placards for first responders in case of an emergency. Please let us know when there are changes to the hazards in the lab so that we may update the door placard. You may also complete a new door placard form and return to Chandra Mccarthy when there are changes or when creating a new placard for your lab.
   - Any incident in the lab must be reported. Incidents with serious injury (e.g. loss of body part, hospitalization, etc.) must be reported right away. Any other incident must be reported within 24 hours. You may report incidents through the EH&S online portal by clicking on the top right tab "Incident/Injury". Additionally, Near Misses should also be reported to provide information and lessons learned. You

may report a near miss through the EH&S online portal by clicking on the top middle tab "Near Miss". For more information regarding reporting incidents and near misses go to: Risk Management

- **UC Chemicals:** You may create an inventory in the UC application Chemicals by clicking *on Create a New Inventory* from the drop down box. For maintaining chemical inventory using the UC Chemicals application, EH&S will provide the lab group with scanner stickers that you can use/assign to chemicals and location. **I am happy to schedule an in person meeting to assist with this if/when you choose to use the program.*

9. **Hazardous Waste Management:** Please refer to the Hazardous Waste section of the EH&S website regarding *UCSB guidelines for HW management and sharps disposal; and Universal Waste Procedures*

10. **Laboratory Safety Review (Inspection) program:** Typically the lab safety specialist assigned to your department would schedule a one-on-one meeting with the supervisor or delegate to conduct a lab safety review which entails (1) Review of administrative controls (2) physical space inspection. However, due to the current health guidelines and COVID mitigation, lab safety reviews are conducted without a lab representative. For more information regarding our Inspection program please go to Laboratory Safety Review Program.

*Note: Beginning January 2022 EH&S will resume the in-person lab safety review.

11. **Minors in Laboratory and Shops Policy**
    - Please review the policy Here

12. **Spill Kit & First Aid "Be Smart About Safety"**
    In an effort to positively influence the safety culture on campus and develop a solid work relationship with faculty, each new PI is provided with an in-house assembled chemical spill kit and first aid kit. This Be Smart About Safety funded program, in addition to our established services, promotes a reduction in workers compensation claims, property damage, and time away from work. **Please let me know if you would like a spill kit or first aid kit or both and I will arrange to drop them off to the lab.*

For more information and resources please go to the EH&S website @
http://www.ehs.ucsb.edu/labsafety/safety-responsibilities-pis-and-supervisors

COVID-19 Information for Researchers:
https://www.ehs.ucsb.edu/labsafety/covid-19-information-researchers

8/25/2021

ENVIRONMENTAL HEALTH AND SAFETY

University of California Santa Barbara

Research Safety Self-Inspection Checklist

Building and Lab Number:

Responsible Party:

Inspected by:

Date:

#	ITEM	Yes	No	N/A	Date Corrected
General Safety					
1	Housekeeping (is aisle space adequate - at least 3 foot clearance)? Are work spaces clean and tidy? Any excess trash? Combustible materials stored orderly and away from ignition sources? Floors clear with no slip (e.g. oil residue or water), trip or fall hazards?				
2	Is the Sanitation standard no food and drink in areas exposed to toxic materials being followed? No Food and/or Drink in a Lab Storage Refrigerator/Freezer?				
3	Other				
Emergency Preparedness and Fire Safety					
4	Emergency shower/eye wash station easily accessible?				
5	Are fire extinguishers easily available and accessible, tag indicates that they have been tested within the last year?				
6	Are all corridors and exits free of obstruction? Are all fire rated doors kept closed (no propped open doors). Mangnetic holders are acceptable.				
7	Is storage ceiling clearance within correct distances (2' for non-sprinkled buildings and 18" for sprinkled buildings)?				
8	Are sprinklers appear to be in good conditions? Are all constructions around the sprinkler in place (ceiling tiles, open holes and etc.)?				
9	Are Spill/First Aid Kits available? Are the contents of the kits re-stocked and within the shelf life? For Labs using Hydrofluoric Acid is Calcium Gluconate available and within the shelf life?				
10	All chemical spills or debris properly cleaned?				
11	Is the Emergency Flip Chart available? Building specific page customized?				
12	Is the door placard present and up-to-date?				
Seismic Safety					
13	Are all tall furniture and equipment (>42") braced? Are shelves used for chemical storage equipped with restrains? No overhead storage of heavy items?				
PPE					
14	Is PPE policy followed by all lab members? If respirators are worn, are users enrolled in the UCSB respiratory protection program?				
Gas Under Pressure					
15	Are gas cylinders: seismically anchored, hydrotested (<10 y), labeled with contents, capped when not in use, inventoried with a barcode, and kept in ventilated area? Any signs of corrosion? Is the applied tubing compatible with the material being used?				
16	Is emergency shutoff for flammable gases installed?				
17	Are oxygen cylinders separated from flammable gas by 20' or a noncombustible barrier at least 5' tall? (i.e. not near electrical or ignition sources, not under stairs.)				
Chemical Storage					
18	Are all chemical containers labeled and in a good condition? Are incompatible chemicals segregated?				
19	Are laboratory freezers clean and defrosted? Are flammables stored in a flammable materials storage (desparked) fridge/freezer?				
20	Are all peroxide formers dated and within the time allowed for storage/use?				
21	Are flammables stored in a flammable liquid storage cabinet? No more than ten 10 gallons of flammable or combustible liquids may be stored outside a flammable cabinet.				
22	Are chemicals stored in a designated storage area? Are there any chemicals stored on the floor or above eye level?				
Hazardous Waste Management					
23	Is the hazardous waste stored properly: capped, in designated area with secondary containment for liquid waste? Is incompatible waste segregated? Is the hazardous waste label completely filled out: chemical name, start date, physical state, chemical hazard clasification? Is the accumulation time less than 9 months?				
24	Is Universal waste (e.g. e-wate, batteries, light bulbs, etc.) properly stored and labeled (type of waste and date)? Is the accumulation time less than 1 year?				
25	Are sharps disposed of in a properly labeled, puncture proved container? Is the container fuller than 2/3rd of its volume?				
Electrical Safety					
26	Is the electrical panel kept closed and easily accessible at all times?				
27	Are all electrical cords in good condition (any frayed cords, tangled cords, tripping hazards)?				
28	Are extension cords used for temporary purpose only? Any daisy chain cords? Are multiple outlet strips equipped with circuit breaker?				
Fume Hoods (CCR Title 8/5154.1)					
29	Is the fume hood cleared of clutter, certified and properly used (sash level not above the safe working height; work area is 6" behind the sash)?				
Equipment Safety					
30	No open flame in a biosafety cabinet/laminar box?				
31	Is all the equipment in good working order with all safety features in place (hearing protection provided if sonicator is present; safety guards in place for moving parts, pinch points, belts; catching oil pans for vacuum pumps, clean and lubricated rotors of centrifuges and etc.)?				
32	Is all equipment labeled for use (research or food storage ; high voltage; not for flammable storage and etc.?)				

For safety questions and conserns:

EEMB, MSI, Bren School, Anthropology, Earth Science, NRS contact **Nelly.Traitcheva@ehs.ucsb.edu 805-893-5129**

Other departments contact: **Chandra.Feeser@ucsb.edu 805-893-3264**

GHS Classification

GHS, the Globally Harmonized System of Classification and Labeling of Chemicals, was developed by the United Nations as a way to bring into agreement the chemical regulations and standards of different countries. GHS includes criteria for the classification of health, physical and environmental hazards, as well as specifying what information should be included on labels of hazardous chemicals as well as safety data sheets. This page summarizes the relationship of GHS hazard statements, pictograms, signal words, hazard classes, categories, and precautionary statements.

Hazard Class Pictograms
GHS Hazard Statements
EU Hazard Statements
SWA Hazard Statements
Precautionary Statements

Ref: UNECE GHS (Rev.8) (2019), UNECE GHS (Rev.7) (2017)

Hazard Class Pictograms

 Exploding Bomb Explosives GHS01	 Flame Flammables GHS02	 Flame Over Circle Oxidizers GHS03
 Gas Cylinder Compressed Gases GHS04	 Corrosion Corrosives GHS05	 Skull and Crossbones Acute Toxicity GHS06
 Exclamation Mark Irritant GHS07	 Health Hazard GHS08	 Environment GHS09

Note: All pictograms are shown in svg format in the page. The corresponding gif images are also available, e.g. https://pubchem.ncbi.nlm.nih.gov/images/ghs/GHS08.gif.

GHS Hazard Statements

Code	Hazard Statements	Hazard Class	Category	Pictogram	Signal Word	Precautionary Statements P-Codes			
						Prevention	Response	Storage	Disposal
H200	Unstable Explosive	Explosives	Unstable Explosive		Danger	P201, P202, P281	P372, P373, P380	P401	P501
H201	Explosive; mass explosion hazard	Explosives	Div 1.1		Danger	P210, P230, P240, P250, P280	P370+P380, P372, P373	P401	P501
H202	Explosive; severe projection hazard	Explosives	Div 1.2		Danger	P210, P230, P240, P250, P280	P370+P380, P372, P373	P401	P501
H203	Explosive; fire, blast or projection hazard	Explosives	Div 1.3		Danger	P210, P230, P240, P250, P280	P370+P380, P372, P373	P401	P501
H204	Fire or projection hazard	Explosives	Div 1.4		Warning	P210, P240, P250, P280	P370+P380, P372, P373, P374	P401	P501

H205	May mass explode in fire	Explosives	Div 1.5	None	Danger	P210, P230, P240, P250, P280	P370+P380, P372, P373	P401	P501
		Explosives	Div 1.6*						
H206	Fire, blast or projection hazard; increased risk of explosion if desensitizing agent is reduced	Desensitized explosives	Category 1		Danger	P210, P212, P230, P233, P280	P370+P380+P375	P401	P501
H207	Fire or projection hazard; increased risk of explosion if desensitizing agent is reduced	Desensitized explosives	Category 2		Danger	P210, P212, P230, P233, P280	P370+P380+P375	P401	P501
H207	Fire or projection hazard; increased risk of explosion if desensitizing agent is reduced	Desensitized explosives	Category 3		Warning	P210, P212, P230, P233, P280	P370+P380+P375	P401	P501
H208	Fire hazard; increased risk of explosion if desensitizing agent is reduced	Desensitized explosives	Category 4		Warning	P210, P212, P230, P233, P280	P371+P380+P375	P401	P501
H220	Extremely flammable gas	Flammable gases	1A: Flammable gas, Pyrophoric gas, Chemically unstable gas A,B		Danger	P210	P377, P381	P403	
H221	Flammable gas	Flammable gases	1B		Danger	P210	P377, P381	P403	
H221	Flammable gas	Flammable gases	Category 2	None	Warning	P210	P377, P381	P403	
H222	Extremely flammable aerosol	Aerosols	Category 1		Danger	P210, P211, P251		P410+P412	
H223	Flammable aerosol	Aerosols	Category 2		Warning	P210, P211, P251		P410+P412	

H224	Extremely flammable liquid and vapor	Flammable liquids	Category 1		Danger	P210, P233, P240, P241, P242, P243, P280	P303+P361+P353, P370+P378	P403+P235	P501
H225	Highly Flammable liquid and vapor	Flammable liquids	Category 2		Danger	P210, P233, P240, P241, P242, P243, P280	P303+P361+P353, P370+P378	P403+P235	P501
H226	Flammable liquid and vapor	Flammable liquids	Category 3		Warning	P210, P233, P240, P241, P242, P243, P280	P303+P361+P353, P370+P378	P403+P235	P501
H227	Combustible liquid	Flammable liquids	Category 4	None	Warning	P210, P280	P370+P378	P403+P235	P501
H228	Flammable solid	Flammable solids	Category 1		Danger	P210, P240, P241, P280	P370+P378		
H228	Flammable solid	Flammable solids	Category 2		Warning	P210, P240, P241, P280	P370+P378		
H229	Pressurized container: may burst if heated	Aerosols	Category 1		Danger	P210, P211, P251		P410+P412	
H229	Pressurized container: may burst if heated	Aerosols	Category 2		Warning	P210, P211, P251		P410+P412	
H229	Pressurized container: may burst if heated	Aerosols	Category 3	None	Warning	P210, P211, P251		P410+P412	
H230	May react explosively even in the absence of air	Flammable gases	1A, Chemically unstable gas A			P202			
H231	May react explosively even in the absence of air at elevated pressure and/or temperature	Flammable gases	1A, Chemically unstable gas B			P202			
H232	May ignite spontaneously if exposed to air	Flammable gases	1A, Pyrophoric gas		Danger	P222			
H240	Heating may cause an explosion	Self-reactive substances and mixtures; Organic peroxides	Type A		Danger	P210, P220, P234, P280	P370+P378, P370+P380+P375	P403+P235, P411, P420	P501

H241	Heating may cause a fire or explosion	Self-reactive substances and mixtures; Organic peroxides	Type B		Danger	P210, P220, P234, P280	P370+P378, P370+P380+P375	P403+P235, P411, P420	P501
H242	Heating may cause a fire	Self-reactive substances and mixtures; Organic peroxides	Type C, D		Danger	P210, P220, P234, P280	P370+P378	P403+P235, P411, P420	P501
H242	Heating may cause a fire	Self-reactive substances and mixtures; Organic peroxides	Type E, F		Warning	P210, P220, P234, P280	P370+P378	P403+P235, P411, P420	P501
		Self-reactive substances and mixtures; Organic peroxides	Type G						
H250	Catches fire spontaneously if exposed to air	Pyrophoric liquids; Pyrophoric solids	Category 1		Danger	P210, P222, P280	P302+P334, P370+P378	P422	
H251	Self-heating; may catch fire	Self-heating substances and mixtures	Category 1		Danger	P235+P410, P280		P407, P413, P420	
H252	Self-heating in large quantities; may catch fire	Self-heating substances and mixtures	Category 2		Warning	P235+P410, P280		P407, P413, P420	
H260	In contact with water releases flammable gases which may ignite spontaneously	Substances and mixtures which in contact with water, emit flammable gases	Category 1		Danger	P223, P231+P232, P280	P335+P334, P370+P378	P402+P404	P501
H261	In contact with water releases flammable gas	Substances and mixtures which in contact with water, emit flammable gases	Category 2		Danger	P223, P231+P232, P280	P335+P334, P370+P378	P402+P404	P501
H261	In contact with water releases flammable gas	Substances and mixtures which in contact with water, emit flammable gases	Category 3		Warning	P231+P232, P280	P370+P378	P402+P404	P501
H270	May cause or intensify fire; oxidizer	Oxidizing gases	Category 1		Danger	P220, P244	P370+P376	P403	
H271	May cause fire or explosion; strong Oxidizer	Oxidizing liquids; Oxidizing solids	Category 1		Danger	P210, P220, P221, P280, P283	P306+P360, P371+P380+P375, P370+P378		P501

H272	May intensify fire; oxidizer	Oxidizing liquids; Oxidizing solids	Category 2		Danger	P210, P220, P221, P280	P370+P378		P501
H272	May intensify fire; oxidizer	Oxidizing liquids; Oxidizing solids	Category 3		Warning	P210, P220, P221, P280	P370+P378		P501
H280	Contains gas under pressure; may explode if heated	Gases under pressure	Compressed gas, Liquefied gas, Dissolved gas		Warning			P410+P403	
H281	Contains refrigerated gas; may cause cryogenic burns or injury	Gases under pressure	Refrigerated liquefied gas		Warning	P282	P336, P315	P403	
H282	Extremely flammable chemical under pressure: may explode if heated	Chemicals under pressure	Category 1		Danger	P210, P211	P370+P378, P376, P381	P410+P403	
H283	Flammable chemical under pressure: may explode if heated	Chemicals under pressure	Category 2		Warning	P210, P211	P370+P378, P376, P381	P410+P403	
H284	Chemical under pressure: may explode if heated	Chemicals under pressure	Category 3		Warning	P210	P376	P410+P403	
H290	May be corrosive to metals	Corrosive to Metals	Category 1		Warning	P234	P390	P404	
H300	Fatal if swallowed	Acute toxicity, oral	Category 1, 2		Danger	P264, P270	P301+P310, P321, P330	P405	P501
H301	Toxic if swallowed	Acute toxicity, oral	Category 3		Danger	P264, P270	P301+P310, P321, P330	P405	P501
H302	Harmful if swallowed	Acute toxicity, oral	Category 4		Warning	P264, P270	P301+P312, P330		P501
H303	May be harmful if swallowed	Acute toxicity, oral	Category 5	None	Warning		P312		
H304	May be fatal if	Aspiration hazard	Category 1		Danger		P301+P310, P331	P405	P501

	swallowed and enters airways								
H305	May be fatal if swallowed and enters airways	Aspiration hazard	Category 2		Warning		P301+P310, P331	P405	P501
H310	Fatal in contact with skin	Acute toxicity, dermal	Category 1, 2		Danger	P262, P264, P270, P280	P302+P350, P310, P322, P361, P363	P405	P501
H311	Toxic in contact with skin	Acute toxicity, dermal	Category 3		Danger	P280	P302+P352, P312, P322, P361, P363	P405	P501
H312	Harmful in contact with skin	Acute toxicity, dermal	Category 4		Warning	P280	P302+P352, P312, P322, P363		P501
H313	May be harmful in contact with skin	Acute toxicity, dermal	Category 5	None			P312		
H314	Causes severe skin burns and eye damage	Skin corrosion/irritation	Category 1A, 1B, 1C		Danger	P260, P264, P280	P301+P330+P331, P303+P361+P353, P363, P304+P340, P310, P321, P305+P351+P338	P405	P501
H315	Causes skin irritation	Skin corrosion/irritation	Category 2		Warning	P264, P280	P302+P352, P321, P332+P313, P362		
H316	Causes mild skin irritation	Skin corrosion/irritation	Category 3	None	Warning		P332+P313		
H317	May cause an allergic skin reaction	Sensitization, Skin	Category 1, 1A, 1B		Warning	P261, P272, P280	P302+P352, P333+P313, P321, P363		P501
H318	Causes serious eye damage	Serious eye damage/eye irritation	Category 1		Danger	P280	P305+P351+P338, P310		
H319	Causes serious eye irritation	Serious eye damage/eye irritation	Category 2A		Warning	P264, P280	P305+P351+P338, P337+P313		
H320	Causes eye irritation	Serious eye damage/eye irritation	Category 2B	None	Warning	P264	P305+P351+P338, P337+P313		
H330	Fatal if inhaled	Acute toxicity, inhalation	Category 1, 2		Danger	P260, P271, P284	P304+P340, P310, P320	P403+P233, P405	P501
H331	Toxic if inhaled	Acute toxicity, inhalation	Category 3		Danger	P261, P271	P304+P340, P311, P321	P403+P233, P405	P501
H332	Harmful if inhaled	Acute toxicity, inhalation	Category 4		Warning	P261, P271	P304+P340, P312, P304+P312		

H333	May be harmful if inhaled	Acute toxicity, inhalation	Category 5	None	Warning	P261, P271	P304+P340, P312, P304+P312		
H334	May cause allergy or asthma symptoms or breathing difficulties if inhaled	Sensitization, respiratory	Category 1, 1A, 1B		Danger	P261, P285	P304+P341, P342+P311		P501
H335	May cause respiratory irritation	Specific target organ toxicity, single exposure; Respiratory tract irritation	Category 3		Warning	P261, P271	P304+P340, P312	P403+P233, P405	P501
H336	May cause drowsiness or dizziness	Specific target organ toxicity, single exposure; Narcotic effects	Category 3		Warning	P261, P271	P304+P340, P312	P403+P233, P405	P501
H340	May cause genetic defects	Germ cell mutagenicity	Category 1A, 1B		Danger	P201, P202, P281	P308+P313	P405	P501
H341	Suspected of causing genetic defects	Germ cell mutagenicity	Category 2		Warning	P201, P202, P281	P308+P313	P405	P501
H350	May cause cancer	Carcinogenicity	Category 1A, 1B		Danger	P201, P202, P281	P308+P313	P405	P501
H350i	May cause cancer by inhalation	Carcinogenicity	Category 1A, 1B		Danger	P201, P202, P281	P308+P313	P405	P501
H351	Suspected of causing cancer	Carcinogenicity	Category 2		Warning	P201, P202, P281	P308+P313	P405	P501
H360	May damage fertility or the unborn child	Reproductive toxicity	Category 1A, 1B		Danger	P201, P202, P281	P308+P313	P405	P501
H360F	May damage fertility	Reproductive toxicity	Category 1A, 1B		Danger	P201, P202, P281	P308+P313	P405	P501
H360D	May damage the unborn child	Reproductive toxicity	Category 1A, 1B		Danger	P201, P202, P281	P308+P313	P405	P501
H360FD	May damage fertility; May damage the unborn child	Reproductive toxicity	Category 1A, 1B		Danger	P201, P202, P281	P308+P313	P405	P501
H360Fd	May damage fertility; Suspected of damaging the unborn child	Reproductive toxicity	Category 1A, 1B		Danger	P201, P202, P281	P308+P313	P405	P501

H360Df	May damage the unborn child; Suspected of damaging fertility	Reproductive toxicity	Category 1A, 1B		Danger	P201, P202, P281	P308+P313	P405	P501
H361	Suspected of damaging fertility or the unborn child	Reproductive toxicity	Category 2		Warning	P201, P202, P281	P308+P313	P405	P501
H361f	Suspected of damaging fertility	Reproductive toxicity	Category 2		Warning	P201, P202, P281	P308+P313	P405	P501
H361d	Suspected of damaging the unborn child	Reproductive toxicity	Category 2		Warning	P201, P202, P281	P308+P313	P405	P501
H361fd	Suspected of damaging fertility; Suspected of damaging the unborn child	Reproductive toxicity	Category 2		Warning	P201, P202, P281	P308+P313	P405	P501
H362	May cause harm to breast-fed children	Reproductive toxicity, effects on or via lactation	Additional category	None		P201, P260, P263, P264, P270	P308+P313		
H370	Causes damage to organs	Specific target organ toxicity, single exposure	Category 1		Danger	P260, P264, P270	P307+P311, P321	P405	P501
H371	May cause damage to organs	Specific target organ toxicity, single exposure	Category 2		Warning	P260, P264, P270	P309+P311	P405	P501
H372	Causes damage to organs through prolonged or repeated exposure	Specific target organ toxicity, repeated exposure	Category 1		Danger	P260, P264, P270	P314		P501
H373	Causes damage to organs through prolonged or repeated exposure	Specific target organ toxicity, repeated exposure	Category 2		Warning	P260	P314		P501
H400	Very toxic to aquatic life	Hazardous to the aquatic environment, acute hazard	Category 1		Warning	P273	P391		P501
H401	Toxic to aquatic life	Hazardous to the aquatic	Category 2	None		P273			P501

		environment, acute hazard						
H402	Harmful to aquatic life	Hazardous to the aquatic environment, acute hazard	Category 3	None		P273		P501
H410	Very toxic to aquatic life with long lasting effects	Hazardous to the aquatic environment, long-term hazard	Category 1		Warning	P273	P391	P501
H411	Toxic to aquatic life with long lasting effects	Hazardous to the aquatic environment, long-term hazard	Category 2			P273	P391	P501
H412	Harmful to aquatic life with long lasting effects	Hazardous to the aquatic environment, long-term hazard	Category 3	None		P273		P501
H413	May cause long lasting harmful effects to aquatic life	Hazardous to the aquatic environment, long-term hazard	Category 4	None		P273		P501
H420	Harms public health and the environment by destroying ozone in the upper atmosphere	Hazardous to the ozone layer	Category 1		Warning			P502
Combined H-Codes								
H300+H310	Fatal if swallowed or in contact with skin	Acute toxicity, oral; acute toxicity, dermal	Category 1, 2		Danger			
H300+H330	Fatal if swallowed or if inhaled	Acute toxicity, oral; acute toxicity, inhalation	Category 1, 2		Danger			
H310+H330	Fatal in contact with skin or if inhaled	Acute toxicity, dermal; acute toxicity, inhalation	Category 1, 2		Danger			
H300+H310+H330	Fatal if swallowed, in contact with skin or if inhaled	Acute toxicity, oral; acute toxicity, dermal; acute toxicity, inhalation	Category 1, 2		Danger			
H301+H311	Toxic if swallowed or in contact with skin	Acute toxicity, oral; acute toxicity, dermal	Category 3		Danger			
H301+H331	Toxic if	Acute toxicity,	Category 3		Danger			

	swallowed or if inhaled	oral; acute toxicity, inhalation			
H311+H331	Toxic in contact with skin or if inhaled.	Acute toxicity, dermal; acute toxicity, inhalation	Category 3		Danger
H301+H311+H331	Toxic if swallowed, in contact with skin or if inhaled	Acute toxicity, oral; acute toxicity, dermal; acute toxicity, inhalation	Category 3		Danger
H302+H312	Harmful if swallowed or in contact with skin	Acute toxicity, oral; acute toxicity, dermal	Category 4		Warning
H302+H332	Harmful if swallowed or if inhaled	Acute toxicity, oral; acute toxicity, inhalation	Category 4		Warning
H312+H332	Harmful in contact with skin or if inhaled	Acute toxicity, dermal; acute toxicity, inhalation	Category 4		Warning
H302+H312+H332	Harmful if swallowed, in contact with skin or if inhaled	Acute toxicity, oral; acute toxicity, dermal; acute toxicity, inhalation	Category 4		Warning
H303+H313	May be harmful if swallowed or in contact with skin	Acute toxicity, oral; acute toxicity, dermal	Category 5	None	Warning
H303+H333	May be harmful if swallowed or if inhaled	Acute toxicity, oral; acute toxicity, inhalation	Category 5	None	Warning
H313+H333	May be harmful in contact with skin or if inhaled	Acute toxicity, dermal; acute toxicity, inhalation	Category 5	None	Warning
H303+H313+H333	May be harmful if swallowed, in contact with skin or if inhaled	Acute toxicity, oral; acute toxicity, dermal; acute toxicity, inhalation	Category 5	None	Warning
H315+H320	Cause skin and eye irritation	Skin corrosion/irritation and serious eye damage/eye irritation	Category 2, 2B		Warning

* Div 1.6 - Meets transportation requirements only. For more information, see A Guide to The Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

EU Hazard Statements

EUH001	Explosive when dry
EUH006	Explosive with or without contact with air
EUH014	Reacts violently with water
EUH018	In use may form flammable/explosive vapor-air mixture
EUH019	May form explosive peroxides
EUH029	Contact with water liberates toxic gas
EUH031	Contact with acids liberates toxic gas
EUH032	Contact with acids liberates very toxic gas
EUH044	Risk of explosion if heated under confinement
EUH059	Hazardous to the ozone layer
EUH066	Repeated exposure may cause skin dryness or cracking
EUH070	Toxic by eye contact
EUH071	Corrosive to the respiratory tract

Safe Work Australia Hazard Statements

AUH001	Explosive when dry
AUH006	Explosive with or without contact with air
AUH014	Reacts violently with water
AUH018	In use, may form flammable/explosive vapor/air mixture
AUH019	May form explosive peroxides
AUH029	Contact with water liberates toxic gas
AUH031	Contact with acid liberates toxic gas
AUH032	Contact with acid liberates very toxic gas
AUH044	Risk of explosion if heated under confinement
AUH066	Repeated exposure may cause skin dryness and cracking
AUH070	Toxic by eye contact
AUH071	Corrosive to the respiratory tract

Precautionary Statements

General Precautionary Statements	
P101	If medical advice is needed, have product container or label at hand.
P102	Keep out of reach of children.
P103	Read label before use

Prevention Precautionary Statements

P201	Obtain special instructions before use.
P202	Do not handle until all safety precautions have been read and understood.
P210	Keep away from heat, hot surface, sparks, open flames and other ignition sources. - No smoking.
P211	Do not spray on an open flame or other ignition source.
P212	Avoid heating under confinement or reduction of the desensitized agent.
P220	Keep away from clothing and other combustible materials.
P221	Take any precaution to avoid mixing with combustibles/...
P222	Do not allow contact with air.
P223	Do not allow contact with water.
P230	Keep wetted with ...
P231	Handle under inert gas.
P232	Protect from moisture.
P233	Keep container tightly closed.
P234	Keep only in original container.
P235	Keep cool.
P240	Ground/bond container and receiving equipment.
P241	Use explosion-proof [electrical/ventilating/lighting/.../] equipment.
P242	Use only non-sparking tools.
P243	Take precautionary measures against static discharge.
P244	Keep valves and fittings free from oil and grease.
P250	Do not subject to grinding/shock/friction/...
P251	Do not pierce or burn, even after use.
P260	Do not breathe dust/fume/gas/mist/vapors/spray.
P261	Avoid breathing dust/fume/gas/mist/vapors/spray.
P262	Do not get in eyes, on skin, or on clothing.
P263	Avoid contact during pregnancy/while nursing.
P264	Wash ... thoroughly after handling.
P270	Do not eat, drink or smoke when using this product.
P271	Use only outdoors or in a well-ventilated area.
P272	Contaminated work clothing should not be allowed out of the workplace.
P273	Avoid release to the environment.
P280	Wear protective gloves/protective clothing/eye protection/face protection.
P281	Use personal protective equipment as required.
P282	Wear cold insulating gloves/face shield/eye protection.
P283	Wear fire resistant or flame retardant clothing.
P284	[In case of inadequate ventilation] Wear respiratory protection.
P285	In case of inadequate ventilation wear respiratory protection.
P231+P232	Handle under inert gas/... Protect from moisture.
P235+P410	Keep cool. Protect from sunlight.

Response Precautionary Statements	
P301	IF SWALLOWED:
P302	IF ON SKIN:
P303	IF ON SKIN (or hair):
P304	IF INHALED:
P305	IF IN EYES:
P306	IF ON CLOTHING:
P307	IF exposed:
P308	IF exposed or concerned:
P309	IF exposed or if you feel unwell
P310	Immediately call a POISON CENTER or doctor/physician.
P311	Call a POISON CENTER or doctor/...
P312	Call a POISON CENTER or doctor/... if you feel unwell.
P313	Get medical advice/attention.
P314	Get medical advice/attention if you feel unwell.
P315	Get immediate medical advice/attention.
P320	Specific treatment is urgent (see ... on this label).
P321	Specific treatment (see ... on this label).
P322	Specific measures (see ...on this label).
P330	Rinse mouth.
P331	Do NOT induce vomiting.
P332	IF SKIN irritation occurs:
P333	If skin irritation or rash occurs:
P334	Immerse in cool water [or wrap in wet bandages].
P335	Brush off loose particles from skin.
P336	Thaw frosted parts with lukewarm water. Do not rub affected area.
P337	If eye irritation persists:
P338	Remove contact lenses, if present and easy to do. Continue rinsing.
P340	Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P341	If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing.
P342	If experiencing respiratory symptoms:
P350	Gently wash with plenty of soap and water.
P351	Rinse cautiously with water for several minutes.
P352	Wash with plenty of water/...
P353	Rinse skin with water [or shower].
P360	Rinse immediately contaminated clothing and skin with plenty of water before removing clothes.
P361	Take off immediately all contaminated clothing.
P362	Take off contaminated clothing.
P363	Wash contaminated clothing before reuse.
P364	And wash it before reuse.[Added in 2015 version]

P370	In case of fire:
P371	In case of major fire and large quantities:
P372	Explosion risk.
P373	DO NOT fight fire when fire reaches explosives.
P374	Fight fire with normal precautions from a reasonable distance.
P376	Stop leak if safe to do so.
P377	Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
P378	Use ... to extinguish.
P380	Evacuate area.
P381	In case of leakage, eliminate all ignition sources.
P390	Absorb spillage to prevent material damage.
P391	Collect spillage.
P301+P310	IF SWALLOWED: Immediately call a POISON CENTER/doctor/...
P301+P312	IF SWALLOWED: call a POISON CENTER/doctor/... IF you feel unwell.
P301+P330+P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P302+P334	IF ON SKIN: Immerse in cool water [or wrap in wet bandages].
P302+P335+P334	Brush off loose particles from skin. Immerse in cool water [or wrap in wet bandages].
P302+P350	IF ON SKIN: Gently wash with plenty of soap and water.
P302+P352	IF ON SKIN: wash with plenty of water.
P303+P361+P353	IF ON SKIN (or hair): Take off Immediately all contaminated clothing. Rinse SKIN with water [or shower].
P304+P312	IF INHALED: Call a POISON CENTER/doctor/... if you feel unwell.
P304+P340	IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P304+P341	IF INHALED: If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do - continue rinsing.
P306+P360	IF ON CLOTHING: Rinse Immediately contaminated CLOTHING and SKIN with plenty of water before removing clothes.
P307+P311	IF exposed: call a POISON CENTER or doctor/physician.
P308+P311	IF exposed or concerned: Call a POISON CENTER/doctor/...
P308+P313	IF exposed or concerned: Get medical advice/attention.
P309+P311	IF exposed or if you feel unwell: call a POISON CENTER or doctor/physician.
P332+P313	IF SKIN irritation occurs: Get medical advice/attention.
P333+P313	IF SKIN irritation or rash occurs: Get medical advice/attention.
P335+P334	Brush off loose particles from skin. Immerse in cool water/wrap in wet bandages.
P337+P313	IF eye irritation persists: Get medical advice/attention.
P342+P311	IF experiencing respiratory symptoms: Call a POISON CENTER/doctor/...
P361+P364	Take off immediately all contaminated clothing and wash it before reuse.
P362+P364	Take off contaminated clothing and wash it before reuse.
P370+P376	in case of fire: Stop leak if safe to do so.
P370+P378	In case of fire: Use ... to extinguish.
P370+P380	In case of fire: Evacuate area.

P370+P380+P375	In case of fire: Evacuate area. Fight fire remotely due to the risk of explosion.
P371+P380+P375	In case of major fire and large quantities: Evacuate area. Fight fire remotely due to the risk of explosion.

Storage Precautionary Statements

P401	Store in accordance with ...
P402	Store in a dry place.
P403	Store in a well-ventilated place.
P404	Store in a closed container.
P405	Store locked up.
P406	Store in corrosive resistant/... container with a resistant inner liner.
P407	Maintain air gap between stacks or pallets.
P410	Protect from sunlight.
P411	Store at temperatures not exceeding ... °C/...°F.
P412	Do not expose to temperatures exceeding 50 °C/ 122 °F.
P413	Store bulk masses greater than ... kg/...lbs at temperatures not exceeding ... °C/...°F.
P420	Store separately.
P422	Store contents under ...
P402+P404	Store in a dry place. Store in a closed container.
P403+P233	Store in a well-ventilated place. Keep container tightly closed.
P403+P235	Store in a well-ventilated place. Keep cool.
P410+P403	Protect from sunlight. Store in a well-ventilated place.
P410+P412	Protect from sunlight. Do not expose to temperatures exceeding 50 °C/122°F.
P411+P235	Store at temperatures not exceeding ... °C/...°F. Keep cool.

Disposal Precautionary Statements

P501	Dispose of contents/container to ...
P502	Refer to manufacturer or supplier for information on recovery or recycling

COMBINED LIST of Particularly Hazardous Substances

revised 2/4/2021

list compiled by Hector Acuna, UCSB

If any of the chemicals listed below are used in your research then complete a Standard Operating Procedure (SOP) for the product as described in the Chemical Hygiene Plan.

Material(s) not on the list does not preclude one from completing an SOP. Other extremely toxic chemicals or other high hazards will require the development of an SOP.

Red= added in 2020 or status change

IARC list 1 are Carcinogenic to humans
IARC list Group 2A Probably carcinogenic to humans
IARC list Group 2B Possibly carcinogenic to humans
Prop 65 known to cause cancer or reproductive toxicity
KNOWN Carcinogens from National Toxicology Program (NTP)
Reasonably Anticipated NTP
EPA Haz list

COMBINED LIST of Particularly Hazardous Substances	CAS	Source from where the material is listed.		
6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10- hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide		Acutely Toxic		
Methanimidamide, N,N-dimethyl-N'-[2-methyl-4-[[(methylamino)carbonyl]oxy]phenyl]-		Acutely Toxic		
1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (Methyl-CCNU)		Prop 65	KNOWN Carcinogens NTP	
1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)		IARC list Group 2A	Reasonably Anticipated NTP	
1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU) (Lomustine)		Prop 65		
1-(o-Chlorophenyl)thiourea		Acutely Toxic		
1,1,1,2-Tetrachloroethane		IARC list Group 2B		
1,1,2,2-Tetrachloroethane		Prop 65	IARC list Group 2B	
1,1-Dichloro-2,2-bis(*p*-chloropheny)ethylene (DDE)		Prop 65		
1,1-Dichloroethane		Prop 65		
1,1-Dimethylhydrazine		IARC list Group 2B	Reasonably Anticipated NT	Prop 65
1,2,3-Propanetriol, trinitrate		Acutely Toxic		
1,2,3-Trichloropropane		IARC list Group 2A	Reasonably Anticipated NT	Prop 65
1,2-Benzenediol, 4-[1-hydroxy-2-(methylamino)ethyl]-,		Acutely Toxic		
1,2-Dibromo-3-chloropropane		IARC list Group 2B	Reasonably Anticipated NT	Prop 65
1,2-Dibromoethane (Ethylene Dibromide)		Reasonably Anticipated NTP		
1,2-Dichloroethane		IARC list 2B	Reasonably Anticipated NTP	
1,2-Dichloropropane		IARC list 1	Prop 65	
1,2-Diethylhydrazine		IARC list2B	Prop 65	
1,2-Dimethylhydrazine		IARC list 2A	Prop 65	
1,2-Epoxybutane		IARC list 2B		
1,2-Propylenimine		Acutely Toxic		
1,3-Butadiene		IARC list 1	KNOWN Carcinogens NTP	Prop 65
1,3-Dichloro-2-propanol		IARC list Group 2B		
1,3-Dichloro-2-propanol (1,3-DCP)		Prop 65		
1,3-Dichloropropene		Prop 65	Reasonably Anticipated NT	IARC list 2B
1,3-dinitropyrene		Prop 65		
1,3-Dithiolane-2-carboxaldehyde, 2,4-dimethyl-, O- [(methylamino)-carbonyl]oxime.		Acutely Toxic		
1,3-Propane sultone		IARC list 2A	Reasonably Anticipated NT	Prop 65
1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa- chloro-1,4,4a,5,8,8a,-hexahydro-,(1alpha,4alpha,4abeta,5alpha,8alpha,8 abeta)-		Acutely Toxic		
1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa- chloro-1,4,4a,5,8,8a-hexahydro-,(1alpha,4alpha,4abeta,5beta,8beta,8ab eta)-		Acutely Toxic		
1,4-Butanediol dimethanesulfonate (Busulfan) or (Myleran®)		Prop 65	KNOWN Carcinogens NTP	
1,4-Dichloro-2-butene		Prop 65		
1,4-Dichloro-2-nitrobenzene	611-06-3	IARC list 2B	Prop 65	

1,4-Dichlorobenzene		Reasonably Anticipated	NTP	
1,4-Dioxane		IARC list 2B	Reasonably Anticipated NT	Prop 65
1,6-Dinitropyrene		IARC list 2B	Reasonably Anticipated NT	Prop 65
1,8-Dinitropyrene		IARC list 2B	Reasonably Anticipated NT	Prop 65
1-[(5-Nitrofurfurylidene)amino]-2-imidazolidinone		IARC list 2B	Prop 65	
1-Acetyl-2-thiourea		Acutely Toxic		
1-Amino-2,4-dibromoanthraquinone		IARC list Group 2B	Reasonably Anticipated NT	Prop 65
1-Amino-2-methylanthraquinone		Reasonably Anticipated	Prop 65	
1-Bromopropane	106-94-5	Prop 65	Reasonably Anticipated NT	IARC list 2B
1-Bromo-3-chloropropane	109-70-6	IARC list 2B		
1-Butyl glycidyl ether	2426-08-6	IARC list 2B		
1-Chloro-2-methylpropene		IARC list 2B		
1-Chloro-4-nitrobenzene		Prop 65	EPA Haz list	
1-Hydroxyanthraquinone		IARC list 2B	Prop 65	
1-Naphthylamine		Prop 65		
1-Nitropyrene		IARC list 2A	Reasonably Anticipated NT	Prop 65
1-tert-Butoxypropan-2-ol	57018-52-7	IARC list 2B		
2-(2-Formylhydrazino)-4-(5-nitro-2-furyl)thiazole		IARC list 2B	Prop 65	
2,2-bis-(Bromoethyl)-1,3-propanediol (Technical Grade)		Reasonably Anticipated	NTP	
2,2-Bis(bromomethyl)-1,3-propanediol		Prop 65		
2,2-Bis(bromomethyl)propane-1,3-diol		IARC list 2B		
2,3,4,7,8-Pentachlorodibenzofuran		IARC list 1		
2,3,7,8-Tetrachlorodibenzo-para-dioxin		IARC list 1		
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD); “Dioxin”		KNOWN Carcinogens N	Prop 65	
2,3-Dibromo-1-propanol		Reasonably Anticipated	Prop 65	
2,3-Dibromopropan-1-ol		IARC list 2B		
2,4,5-Trimethylaniline and its strong acid salts		Prop 65		
2,4,6-Trichlorophenol	88-06-2	IARC list 2B	Reasonably Anticipated NT	Prop 65
2,4.6-Trinitrotoluene (TNT)		Prop 65		
2,4-Diaminoanisole		IARC list 2B	Prop 65	
2,4-Diaminoanisole Sulfate		Reasonably Anticipated	Prop 65	
2,4-Diamino-6-chloro-s -triazine (DACT)		Prop 65		
2,4-Diaminotoluene		IARC list 2B	Reasonably Anticipated NT	Prop 65
2,4-Dichloro-1-nitrobenzene	611-06-3	Prop 65	IARC list 2B	
2,4-Dinitroaniline		EPA Haz list		
2,4-Dinitrophenol		Acutely Toxic		
2,4-Dinitrotoluene		IARC list 2B	Prop 65	
2,4-Hexadienal		IARC list Group 2B	Prop 65	
2,4-Hexadienal (89% trans, trans isomer; 11% cis, trans isomer)		Prop 65		
2,5-Hexanedione		Prop 65		
2,6-Dimethylaniline (2,6-Xylidine)		IARC list 2B		
2,6-Dimethyl-N-nitrosomorpholine (DMNM)		Prop 65	EPA Haz list	
2,6-Dinitrotoluene		IARC list 2B	Prop 65	
2,6-Dinitrotoluene		IARC list Group 2A		
2,6-Xylidine (2,6-Dimethylaniline)		Prop 65		
2-Acetylaminofluorene		Reasonably Anticipated	Prop 65	
2-Amino-1-methyl-6-phenylimidazo[4,5-b]pyridine (PhIP)		Reasonably Anticipated	NTP	

2-Amino-3,4-dimethylimidazo[4,5-f]quinoline (MeIQ)		Reasonably Anticipated	NTP	
2-Amino-3,8-dimethylimidazo[4,5-f]quinoxaline (MeIQx)		Reasonably Anticipated	NTP	
2-Amino-3-methylimidazo[4,5-f]quinoline (IQ)		Reasonably Anticipated	NTP	
2-Amino-4-chlorophenol	95-85-2	Prop 65	IARC list 2B	
2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole		IARC list 2B	Prop 65	
2-Aminoanthraquinone		Reasonably Anticipated	Prop 65	
2-Aminofluorene		Prop 65		
2-Bromopropane		Prop 65		
2-Butanone, 3,3-dimethyl-1(methylthio)-, O-[methylamino)carbonyl] oxime		Acutely Toxic		
2-Chloropropionic acid		Prop 65		
2-Chloronitrobenzene	88-73-3	Prop 65	IARC list 2B	
2-Cyclohexyl-4,6-dinitrophenol		Acutely Toxic		
2H-1-Benzopyran-2-one, 4-hydroxy-3-(3- oxo-1-phenylbutyl)-, & salts, when present at concentrations greater than 0.3%		Acutely Toxic		
2-Mercaptobenzothiazole	149-30-4	IARC list 2A		
2-Methyl-1-nitroanthraquinone (uncertain purity)		IARC list 2B	Prop 65	
2-Methylaziridine (Propyleneimine)		IARC list 2B	Reasonably Anticipated NT	Prop 65
2-methylimidazole		Prop 65		
2-Methylimidazole		IARC list Group 2B		
2-Methyllactonitrile		Acutely Toxic		
2-Naphthylamine		KNOWN Carcinogens N	IARC list Group 1	Prop 65
2-Nitroanisole		IARC list 2B		
2-Nitrofluorene		IARC list 2B	Prop 65	
2-Nitropropane		IARC list 2B	Reasonably Anticipated NT	Prop 65
2-Nitrotoluene		IARC list 2A		
2-Propanone, 1-bromo-		Acutely Toxic		
2-Propen-1-ol		Acutely Toxic		
2-Propenal		Acutely Toxic		
2-Propyn-1-ol		Acutely Toxic		
3(2H)-Isoxazolone, 5-(aminomethyl)-		Acutely Toxic		
3-(N-Nitrosomethylamino)propionitrile		IARC list 2B	Prop 65	
3,3',4,4' Tetrachloroazobenzene	14047-09-7	IARC list 2A	Prop 65	
3,3´-Dichlorobenzidine and 3,3´-Dichlorobenzidine Dihydrochloride		Reasonably Anticipated	NTP	
3,3´-Dimethoxybenzidine (See 3,3´-Dimethoxybenzidine and Dyes Metabolized to 3,3´-Dimethoxybenzidine)		Reasonably Anticipated	NTP	
3,3´-Dimethylbenzidine (See 3,3´-Dimethylbenzidine and Dyes Metabolized to 3,3´-Dimethylbenzidine)		Reasonably Anticipated	NTP	
3,3'-Dichloro-4,4'-diaminodiphenyl ether		IARC list 2B	Prop 65	
3,3'-Dichlorobenzidine		IARC list 2B	Prop 65	
3,3'-Dichlorobenzidine dihydrochloride		Prop 65		
3,3'-Dimethoxybenzidine (ortho-Dianisidine)		IARC list 2B	Prop 65	
3,3'-Dimethoxybenzidine dihydrochloride		Prop 65		
3,3'-Dimethoxybenzidine-based dyes metabolized to 3,3'-dimethoxybenzidine		Prop 65		
3,3'-Dimethylbenzidine (ortho-Tolidine)		IARC list 2B	Prop 65	
3,3'-Dimethylbenzidine dihydrochloride		Prop 65		
3,3'-Dimethylbenzidine-based dyes metabolized to 3,3'-dimethylbenzidine		Prop 65		
3,4,5,3',4'-Pentachlorobiphenyl (PCB-126)		IARC list 1		
3,7-Dinitrofluoranthene		IARC list 2B	Prop 65	
3,9-Dinitrofluoranthene		IARC list 2B	Prop 65	
3-Amino-9-ethylcarbazole hydrochloride		Prop 65		

3-Chloro-2-methylpropene technical grade	563-47-3	Reasonably Anticipated	Prop 65	IARC list 2B
3-Chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone		IARC list 2B		
3-Chloropropionitrile		Acutely Toxic		
3-Isopropylphenyl N-methylcarbamate.		Acutely Toxic		
3-Methylcholanthrene		Prop 65		
3-Monochloro-1,2-propanediol		IARC list Group 2B		
3-Monochloropropane-1,2-diol (3-MCDP)		Prop 65		
3-Nitrobenzanthrone		IARC list Group 2B		
4-(N-Nitrosomethylamino)-1-(3-pyridyl)-1-butanone		Reasonably Anticipated	Prop 65	
4,4´-Methylenebis(2-chloroaniline)		Reasonably Anticipated	NTP	
4,4´-Methylenedianiline and Its Dihydrochloride Salt		Reasonably Anticipated	NTP	
4,4´-Oxydianiline		Reasonably Anticipated	NTP	
4,4´-Thiodianaline		Reasonably Anticipated	NTP	
4,4'-Diaminodiphenyl ether		IARC list 2B	Prop 65	
4,4'-Methylene bis(2-chloroaniline)		Prop 65		
4,4'-Methylene bis(2-methylaniline)		IARC list 2B	Prop 65	
4,4'-Methylene bis(N,N-dimethyl)benzenamine		Prop 65		
4,4'-Methylenebis(2-chloroaniline) (MOCA)		IARC list 1		
4,4'-Methylenedianiline		IARC list 2B	Prop 65	
4,4'-Methylenedianiline dihydrochloride		Prop 65		
4,4'-Thiodianiline		IARC list 2B	Prop 65	
4,6-Dinitro-o-cresol, & salts		Acutely Toxic		
4,7,7a-tetrahydro-4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a		Acutely Toxic		
4-4´-Methylenebis(N,N-dimethyl)benzenamine		Reasonably Anticipated	NTP	
4-Amino-2-nitrophenol		Prop 65		
4-Aminobiphenyl		IARC list 1		
4-Aminobiphenyl		KNOWN Carcinogens N	IARC list Group 1	Prop 65
4-Aminopyridine		Acutely Toxic		
4-Chlorobenzotrifluoride	98-56-6	IARC list 2B		
4-Chloronitrobenzene	100-00-5	IARC list 2B		
4-Chloro-ortho-phenylenediamine		IARC list 2B	Prop 65	Reasonably Anticipated NTP
4-Chloro-ortho-toluidine		IARC list 2A		
4-Dimethylaminoazobenzene		Reasonably Anticipated	Prop 65	
4-methylimidazole		Prop 65		
4-Methylimidazole		IARC list Group 2B		
4-Nitrobiphenyl		Prop 65		
4-Nitropyrene		IARC list 2B	Prop 65	Reasonably Anticipated NTP
4-Pyridinamine		Acutely Toxic		
4-Vinyl-1-cyclohexene Diepoxide (Vinyl cyclohexenedioxide)		Reasonably Anticipated	Prop 65	
4-Vinylcyclohexene		IARC list 2B	Prop 65	
4-Vinylcyclohexene diepoxide		IARC list 2B		
5-(Aminomethyl)-3-isoxazolol		Acutely Toxic		
5-(Morpholinomethyl)-3-[(5-nitrofurfurylidene)amino]-2-oxazolidinone		IARC list 2B	Prop 65	
5-Chloro-*o* -toluidine and its strong acid salts		Prop 65		
5-Methoxypsoralen		IARC list 2A	Prop 65	
5-Methylchrysene		IARC list 2B	Prop 65	Reasonably Anticipated NTP
5-Nitroacenaphthene		IARC list 2B	Prop 65	

6-Nitrochrysene		IARC list 2A	Prop 65	Reasonably Anticipated NTP	
7,12-Dimethylbenz(a)anthracene		Prop 65			
7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-, methylcarbamate.		Acutely Toxic			
7H-Dibenzo[c,g]carbazole		IARC list 2B	Prop 65	Reasonably Anticipated NTP	
7H-Dibenzo[c,g]carbazole		IARC list Group 2B			
7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid		Acutely Toxic			
8-Methoxypsoralen with ultraviolet A therapy		Prop 65			
α-Methylstyrene		IARC list Group 2B			
A-alpha-C (2-Amino-9H-pyrido[2,3-b]indole)		IARC list 2B	Prop 65		
Abiraterone acetate		Prop 65			
Acetaldehyde		IARC list 2B	Prop 65	Reasonably Anticipated NTP	
Acetaldehyde associated with consumption of alcoholic		IARC list 1			
Acetaldehyde, chloro-		Acutely Toxic			
Acetamide		IARC list 2B	Prop 65		
Acetamide, 2-fluoro-		Acutely Toxic			
Acetamide, N-(aminothioxomethyl)-		Acutely Toxic			
Acetazolamide		Prop 65			
Acetic acid, fluoro-, sodium salt		Acutely Toxic			
Acetochlor		Prop 65			
Acetohydroxamic acid		Prop 65			
Acetone Cyanohydrin		EPA Haz list			
Acetone Thiosemicarbazide		EPA Haz list			
Acid mists, strong inorganic		IARC list 1			
Acifluorfen sodium		Prop 65			
Acheson process, occupational exposure associated with		IARC list 1			
Acrolein		EPA Haz list			
Acrylamide		IARC list 2A	Reasonably Anticipated NT	Prop 65	EPA Haz list
Acrylonitrile		IARC list 2B	Reasonably Anticipated NT	Prop 65	EPA Haz list
Acrylyl Chloride		EPA Haz list			
Actinomycin D		Prop 65			
Adiponitrile		EPA Haz list			
Adriamycin (Doxorubicin Hydrochloride)		IARC list 2A	Reasonably Anticipated NTP		
AF-2 [2-(2-Furyl)-3-(5-nitro-2-furyl)acrylamide]		IARC list 2B	Prop 65		
Aflatoxins		KNOWN Carcinogens N	IARC list Group 1	Prop 65	
Alachlor		Prop 65			
Alcoholic beverages		IARC list 1	KNOWN Carcinogens NTP	Prop 65	
Aldicarb		EPA Haz list			
Aldicarb sulfone		Acutely Toxic			
Aldrin		Prop 65	EPA Haz list		
All-trans retinoic acid		Prop 65			
Allyl Alcohol		EPA Haz list			
Allylamine		EPA Haz list			
Aloe vera , whole leaf extract		IARC list 2B	Prop 65		
alpha,alpha-Dimethylphenethylamine		Acutely Toxic			
alpha-Chlorinated toluenes (benzal chloride, benzotrichloride, benzyl chloride) and benzoyl chloride		IARC list 2A			
alpha-Methyl styrene		Prop 65			
alpha-Naphthylthiourea		Acutely Toxic			

Alprazolam		Prop 65		
Altretamine		Prop 65		
Aluminium production		IARC list 1		
Aluminum Phosphide		EPA Haz list		
Amantadine hydrochloride		Prop 65		
a-methyl styrene		Prop 65		
Amikacin sulfate		Prop 65		
Aminoglutethimide		Prop 65		
Aminoglycosides		Prop 65		
Aminopterin		Prop 65	EPA Haz list	
Amiodarone hydrochloride		Prop 65		
Amiton		EPA Haz list		
Amiton Oxalate		EPA Haz list		
Amitraz		Prop 65		
Amitrole		Reasonably Anticipated	Prop 65	
Ammonia		EPA Haz list		
Ammonium picrate		Acutely Toxic		
Ammonium vanadate		Acutely Toxic		
Amoxapine		Prop 65		
Amphetamine		EPA Haz list		
Amsacrine		IARC list 2B	Prop 65	
Anabolic steroids		Prop 65		
Analgesic Mixtures Containing Phenacetin (See Phenacetin and Analgesic Mixtures Containing Phenacetin)		KNOWN Carcinogens N	Prop 65	
Androgenic (anabolic) steroids		IARC list 2A		
Androstenedione		Prop 65		
Angiotensin converting enzyme (ACE) inhibitors		Prop 65		
Aniline		Prop 65	EPA Haz list	
Aniline hydrochloride		Prop 65		
Aniline, 2,4,6-Trimethyl-		EPA Haz list		
Anisindione		Prop 65		
Anthraquinone		Prop 65		
Anthraquinone		IARC list Group 2B		
Antimony oxide (Antimony trioxide)		Prop 65		
Antimony Pentafluoride		EPA Haz list		
Antimony trioxide		IARC list 2B		
Antimycin A		EPA Haz list		
ANTU		EPA Haz list		
Aramite®		IARC list 2B	Prop 65	
Areca nut		IARC list 1	Prop 65	
Argentate(1-), bis(cyano-C)-,potassium		Acutely Toxic		
Aristolochic acid		IARC list 1	Prop 65	KNOWN Carcinogens NTP
Aristolochic acid, plants containing		IARC list 1		
Arsenic (inorganic oxides)		Prop 65		
Arsenic acid		Acutely Toxic		
Arsenic Compounds, Inorganic		KNOWN Carcinogens N	IARC list Group 1	Prop 65
Arsenic oxide		Acutely Toxic		
Arsenic Pentoxide		EPA Haz list		

Arsenic trioxide		Acutely Toxic		
Arsenous Oxide		EPA Haz list		
Arsenous Trichloride		EPA Haz list		
Arsine		EPA Haz list		
Arsine, diethyl		Acutely Toxic		
Arsonous dichloride, phenyl-		Acutely Toxic		
Asbestos		KNOWN Carcinogens N	IARC list Group 1	Prop 65
Atenolol		Prop 65		
Atrazine		Prop 65		
Auramine		IARC list 2B	Prop 65	
Auramine production		IARC list 1		
Auranofin		Prop 65		
Avermectin B1 (Abamectin		Prop 65		
Azacitidine		IARC list 2A	Reasonably Anticipated NT	Prop 65
Azaserine		IARC list 2B	Prop 65	
Azathioprine		IARC list 1	KNOWN Carcinogens NTP	Prop 65
Azinphos-Ethyl		EPA Haz list		
Azinphos-Methyl		EPA Haz list		
Aziridine		IARC list 2B	Acutely Toxic	
Aziridine, 2-methyl-		Acutely Toxic		
Azobenzene		Prop 65		
Barbiturates		Prop 65		
Barium cyanide		Acutely Toxic		
Basic Red 9 Monohydrochloride (basic fuchsin dye)		Reasonably Anticipated NTP		
Beclomethasone dipropionate		Prop 65		
Benomyl		Prop 65		
Benthiavalicarb-isopropyl		Prop 65		
Benz[a]anthracene		IARC list 2B	Reasonably Anticipated NT	Prop 65
Benz[j]aceanthrylene		IARC list 2B		
Benzal Chloride		EPA Haz list		
Benzenamine, 3-(Trifluoromethyl)-		EPA Haz list		
Benzenamine, 4-chloro-		Acutely Toxic		
Benzenamine, 4-nitro-		Acutely Toxic		
Benzene		IARC list 1	KNOWN Carcinogens NTP	Prop 65
Benzene, (chloromethyl)-		Acutely Toxic		
Benzene, 1-(Chloromethyl)-4-Nitro-		EPA Haz list		
Benzenearsonic Acid		EPA Haz list		
Benzeneethanamine, alpha,alpha- dimethyl-		Acutely Toxic		
Benzenethiol		Acutely Toxic		
Benzidine		IARC list 1	KNOWN Carcinogens NTP	Prop 65
Benzidine, dyes metabolized to		IARC list 1		
Benzidine-based dyes		Prop 65		
Benzimidazole, 4,5-Dichloro-2-(Trifluoromethyl)-		EPA Haz list		
Benzo[a]pyrene		IARC list 1	Reasonably Anticipated NT	Prop 65
Benzo[b]fluoranthene		IARC list 2B	Reasonably Anticipated NT	Prop 65
Benzo[c]phenanthrene		IARC list 2B		
Benzo[j]fluoranthene		IARC list 2B	Reasonably Anticipated NT	Prop 65

Benzo[k]fluoranthene		IARC list 2B	Reasonably Anticipated NT	Prop 65	
Benzodiazepines		Prop 65			
Benzofuran		IARC list 2B	Prop 65		
Benzoic acid, 2-hydroxy-, compd. With (3aS-cis)-1,2,3,3a,8,8a-hexahydro-1,3a,8-trimethylpyrrolo[2,3-b]indol-5-yl methylcarbamate ester (1:1)		Acutely Toxic			
benzophenone		Prop 65			
Benzophenone		IARC list Group 2B			
Benzotrichloride		Reasonably Anticipated	Prop 65	EPA Haz list	
Benzphetamine hydrochloride		Prop 65			
Benzyl chloride		Prop 65	EPA Haz list	Acutely Toxic	
Benzyl Cyanide		EPA Haz list			
Benzyl violet		IARC list 2B	Prop 65		
Beryllium and beryllium compounds		IARC list 1	KNOWN Carcinogens NTP	Prop 65	
Beryllium oxide		Prop 65			
Beryllium powder		Acutely Toxic			
Beryllium sulfate		Prop 65			
beta-Butyrolactone		IARC list 2B	Prop 65		
beta-Propiolactone		IARC list 2B	Prop 65	Reasonably Antic	Acutely Toxic
beta-Myrcene	123-35-3	IARC list 2B	Prop 65		
Betel quid with tobacco		IARC list 1	Prop 65		
Betel quid without tobacco		IARC list 1	Prop 65		
Bevacizumab	216974-75-3	Prop 65			
Bicyclo[2.2.1]Heptane-2-Carbonitrile, 5-Chloro-6-((((Methylamino)Carbonyl)Oxy)Imino)-, (1s-(1-alpha,2-beta,4-alpha,5-alpha,6E))-		EPA Haz list			
Biomass fuel (primarily wood), indoor emissions from household combustion of		IARC list 2B			
Bis(2-chloro-1-methylethyl)ether, technical grade		Prop 65			
Bis(2-chloroethyl)ether		Prop 65			
bis(Chloroethyl) nitrosourea		Reasonably Anticipated	NTP		
Bis(Chloromethyl) Ketone		EPA Haz list			
Bis(chloromethyl)ether; chloromethyl methyl ether		IARC list 1	KNOWN Carcinogens NTP	Prop 65	
Bischloroethyl nitrosourea (BCNU)		IARC list 2A	Prop 65		
Bisphenol A (BPA)	80-05-7	Prop 65			
Bitoscanate		EPA Haz list			
Bitumens, extracts of steam-refined and air-refined		IARC list 2B	Prop 65		
Bitumens, occupational exposure to hard bitumens and their emissions during mastic asphalt work		IARC list Group 2B			
Bitumens, occupational exposure to oxidized bitumens and their emssions during roofing		IARC list Group 2A			
Bitumens, occupational exposure to straight-run bitumens and their emissions during road paving		IARC list Group 2B			
BK polyomavirus (BKV)		IARC list Group 2B			
Bleomycins		IARC list 2B			
Boron Trichloride		EPA Haz list			
Boron Trifluoride		EPA Haz list			
Boron Trifluoride Compound With Methyl Ether (1:1)		EPA Haz list			
Bracken fern		IARC list 2B	Prop 65		
Bromacil lithium salt		Prop 65			
Bromadiolone		EPA Haz list			
Bromate		Prop 65			
Bromine		EPA Haz list			
Bromoacetone		Acutely Toxic			
Bromodichloroacetic acid		Prop 65			

Bromochloroacetic acid		IARC list Group 2B		
Bromodichloromethane		Prop 65		
Bromodichloromethane		IARC list 2B	Reasonably Anticipated NTP	
Bromoethane		Prop 65		
Bromoform		Prop 65		
Bromoxynil		Prop 65		
Bromoxynil octanoate		Prop 65		
1-Bromopropane (1-BP)		Prop 65		
Brucine		Acutely Toxic		
Busulfan		IARC list 1		
Butabarbital sodium		Prop 65		
Butyl benzyl phthalate (BBP)		Prop 65		
Butylated hydroxyanisole		Prop 65		
Butylated hydroxyanisole (BHA)		IARC list 2B	Reasonably Anticipated NTP	
C.I. Acid Red 114		Prop 65		
C.I. Basic Red 9 Monohydrochloride		Reasonably Anticipated	Prop 65	
C.I. Direct Blue 15		Prop 65		
C.I. Direct Blue 218		Prop 65		
C.I. Solvent Yellow 14		Prop 65		
Cacodylic acid		Prop 65		
Cadmium and Cadmium Compounds		KNOWN Carcinogens N	IARC list 1	Prop 65
Cadmium Oxide		EPA Haz list		
Cadmium Stearate		EPA Haz list		
Caffeic acid		IARC list 2B	Prop 65	
Calcium Arsenate		EPA Haz list		
Calcium cyanide		Acutely Toxic		
Camphechlor		EPA Haz list		
Cannabis (marijuana) smoke		Prop 65		
Cantharidin		EPA Haz list		
Captafol		IARC list 2A	Prop 65	Reasonably Anticipated NTP
Captan		Prop 65		
Carbachol Chloride		EPA Haz list		
Carbamazepine		Prop 65		
Carbamic acid, [(dibutylamino)- thio]methyl-, 2,3-dihydro-2,2- dimethyl- 7-benzofuranyl ester.		Acutely Toxic		
Carbamic acid, dimethyl-, 1-[(dimethyl- amino)carbonyl]- 5-methyl-1H- pyrazol-3-yl ester.		Acutely Toxic		
Carbamic acid, dimethyl-, 3-methyl-1-(1-methylethyl)-1H- pyrazol-5-yl ester.		Acutely Toxic		
Carbamic acid, methyl-, 3-methylphenyl ester.		Acutely Toxic		
Carbamic Acid, Methyl-, O-(((2,4-Dimethyl-1, 3-Dithiolan-2-yl)Methylene)Amino)-		EPA Haz list		
Carbaryl		Prop 65		
Carbazole		Prop 65		
Carbazole		IARC list Group 2B		
Carbofuran		EPA Haz list	Acutely Toxic	
Carbon black (airborne, unbound particles of respirable size)		IARC list 2B	Prop 65	
Carbon Disulfide		EPA Haz list	Prop 65	Acutely Toxic
Carbon electrode manufacture		IARC list 2A		
Carbon monoxide		Prop 65		
Carbon nanotubes, multi-walled MWCNT-7	308068-56-6	IARC list 2B		

Carbon tetrachloride		IARC list 2B	Prop 65	Reasonably Anticipated NTP
Carbon-black extracts		Prop 65		
Carbonic dichloride		Acutely Toxic		
Carbophenothion		EPA Haz list		
Carboplatin		Prop 65		
Carbosulfan		Acutely Toxic		
Carrageenan, degraded (Poligeenan)		IARC list 2B		
Catechol		IARC list 2B	Prop 65	
Ceramic Fibers (Respirable Size)		Reasonably Anticipated	Prop 65	
Certain combined chemotherapy for lymphomas		Prop 65		
Chenodiol		Prop 65		
Chlomaphazine		IARC list 1		
Chloral		IARC list 2A	Prop 65	
Chloral Hydrate		IARC list 2A	Prop 65	
Chlorambucil		KNOWN Carcinogens N	Prop 65	IARC list 1
Chloramphenicol		IARC list 2A	Reasonably Anticipated NTP	
Chlorcyclizine hydrochloride		Prop 65		
Chlordane		IARC list 2B	Prop 65	EPA Haz list
Chlordecone (Kepone)		IARC list 2B	Prop 65	
Chlordiazepoxide		Prop 65		
Chlordiazepoxide hydrochloride		Prop 65		
Chlordimeform		Prop 65		
Chlorendic acid		IARC list 2B	Prop 65	Reasonably Anticipated NTP
Chlorfenvinfos		EPA Haz list		
Chlorinated Paraffins (Chlorinated paraffins C12 and average degree of chlorination approximately 60%)		Reasonably Anticipated	Prop 65	IARC list 2B
Chlorine		EPA Haz list		
Chlormephos		EPA Haz list		
Chlormequat Chloride		EPA Haz list		
Chlornaphazine		IARC list 1		
Chlorpyrifos	2921-88-2	Prop 65		
Chloroacetaldehyde		Acutely Toxic		
Chloroacetic Acid		EPA Haz list		
Chloroethane (Ethyl chloride)		Prop 65		
Chloroethanol		EPA Haz list		
Chloroethyl Chloroformate		EPA Haz list		
Chloroform		IARC list 2B	Prop 65	Reasonably Antic EPA Haz list
Chloromethyl Ether		EPA Haz list		
Chloromethyl methyl ether (technical grade)		Prop 65	EPA Haz list	KNOWN Carcinogens NTP
Chlorophacinone		EPA Haz list		
Chlorophenoxy herbicides or 2,4-D (2,4-dichlorophenoxyacetic acid)	94-75-7	IARC list 2B		
Chloroprene		Reasonably Anticipated	Prop 65	IARC list 2B
Chlorothalonil		IARC list 2B	Prop 65	
Chlorotrianisene		Prop 65		
Chloroxuron		EPA Haz list		
Chlorozotocin		IARC list 2A	Prop 65	Reasonably Anticipated NTP
Chlorthiophos		EPA Haz list		
Chromic Chloride		EPA Haz list		

Chromium Hexavalent Compounds		KNOWN Carcinogens N	Prop 65	IARC list 1
Chrysene		IARC list 2B	Prop 65	
CI Acid Red 114		IARC list 2B		
CI Basic Red 9		IARC list 2B		
CI Direct Blue		IARC list 2B		
C.I. Disperse Yellow 3		Prop 65	EPA Haz list	
Ciclosporin (Cyclosporin A; Cyclosporine)		Prop 65		
Cidofovir		Prop 65		
Cinnamyl anthranilate		Prop 65		
Cisplatin		IARC list 2A	Prop 65	Reasonably Anticipated NTP
Citrus Red No. 2		IARC list 2B	Prop 65	
Cladribine		Prop 65		
Clarithromycin		Prop 65		
Clobetasol propionate		Prop 65		
Clofibrate		Prop 65		
Clomiphene citrate		Prop 65		
Clonorchis sinensis (infection with)		IARC list 1		
Clorazepate dipotassium		Prop 65		
CMNP (pyrazachlor)		Prop 65		
Coal gasification		IARC list 1		
Coal Tar Pitches (See Coal Tars and Coal Tar Pitches)		KNOWN Carcinogens N	IARC list 1	
Coal Tars (See Coal Tars and Coal Tar Pitches)		KNOWN Carcinogens NTP		
Coal-tar distillation		IARC list 1		
Cobalt and cobalt compounds		IARC list 2B	Prop 65	Reasonably Anticipated NTP
Cobalt Carbonyl		EPA Haz list		
Cobalt metal powder		Prop 65	Reasonably Anticipated NTP	
Cobalt metal with tungsten carbide		IARC list 2A	Reasonably Anticipated NTP	
Cobalt metal without tungsten carbide		IARC list 2B		
Cobalt Sulfate		Reasonably Anticipated	Prop 65	IARC list 2B
Cobalt sulfate heptahydrate		Prop 65		
Cobalt, ((2,2'-(1,2-Ethanediylbis (Nitrilomethylidyne)) Bis(6-Fluorophenolato))(2-)-N,N',O,O')-		EPA Haz list		
Cocaine		Prop 65		
Coconut oil diethanolamine condensate		IARC list Group 2B		
coconut oil diethanolamine condensate (cocamide diethanolamine)		Prop 65		
Codeine phosphate		Prop 65		
Coke Oven Emissions		KNOWN Carcinogens N	Prop 65	IARC list 1
Colchicine		EPA Haz list	Prop 65	
Conjugated estrogens		Prop 65		
Copper cyanide		Acutely Toxic		
Coumaphos		EPA Haz list		
Coumatetralyl		EPA Haz list		
Creosotes		IARC list 2A	Prop 65	
Cresol, o-		EPA Haz list		
Crimidine		EPA Haz list		
Crotonaldehyde		EPA Haz list		
Crotonaldehyde, (E)-		EPA Haz list		
Cumene		IARC list Group 2B	Reasonably Anticipated NT	Prop 65

Cumene Hydroperoxide		EPA Haz list		
Cupferron		Reasonably Anticipated	Prop 65	
Cyanazine		Prop 65		
Cyanides (soluble cyanide salts), not otherwise specified		Acutely Toxic		
Cyanogen		Acutely Toxic		
Cyanogen Bromide		EPA Haz list		
Cyanogen chloride		Acutely Toxic		
Cyanogen Iodide		EPA Haz list		
Cyanophos		EPA Haz list		
Cyanuric Fluoride		EPA Haz list		
Cycasin		IARC list 2B	Prop 65	
Cycloate		Prop 65		
Cycloheximide		Prop 65		
Cycloheximide		EPA Haz list		
Cyclohexylamine		EPA Haz list		
Cyclopenta[cd]pyrene		IARC list 2A	Prop 65	
Cyclophosphamide		IARC list 1	Prop 65	KNOWN Carcinogens NTP
Cyclosporin A		KNOWN Carcinogens NTP		
Cyclosporine		IARC list 1		
Cyhexatin		Prop 65		
Cytarabine		Prop 65		
Cytembena		Prop 65		
D&C Orange No. 17		Prop 65		
D&C Red No. 19		Prop 65		
D&C Red No. 8		Prop 65		
D&C Red No. 9		Prop 65		
Dacarbazine		Prop 65		
Dacarbazine		IARC list 2B	Prop 65	Reasonably Anticipated NTP
Daminozide		Prop 65		
Danazol		Prop 65		
Dantron (Chrysazin; 1,8-Dihydroxyanthraquinone)		IARC list 2B	Prop 65	Reasonably Anticipated NTP
Daunomycin		IARC list 2B	Prop 65	
Daunorubicin hydrochloride		Prop 65		
DDD (Dichlorodiphenyl-dichloroethane)		Prop 65		
DDE (Dichlorodiphenyl-dichloroethylene)		Prop 65		
DDT (4,4'-Dichlorodiphenyltrichloroethane)	50-29-3	IARC list 2A	Prop 65	
DDVP (Dichlorvos)		Prop 65		
Decaborane(14)		EPA Haz list		
Demeclocycline hydrochloride (internal use)		Prop 65		
Demeton		EPA Haz list		
Demeton-S-Methyl		EPA Haz list		
Des-ethyl atrazine (DEA)		Prop 65		
Des-isopropyl atrazine (DIA)		Prop 65		
di(2-Ethylhexyl) Phthalate		Reasonably Anticipated	Prop 65	
Di(2-ethylhexyl)phthalate		IARC list Group 2B		
Dialifor		EPA Haz list		
Diaminotoluene (mixed)		Prop 65		

Diazepam		Prop 65		
Diazoaminobenzene		Reasonably Anticipated	Prop 65	
Diazoxide		Prop 65		
Diazinon	333-41-5	IARC list 2A		
Dibenz[a,h]acridine (See Polycyclic Aromatic Hydrocarbons)		Reasonably Anticipated	IARC list 2B	Prop 65
Dibenz[a,c]anthracene		Prop 65		
Dibenz[a,h]anthracene		IARC list 2A	Prop 65	Reasonably Anticipated NTP
Dibenz[a,j]anthracene		Prop 65		
Dibenzanthracenes		Prop 65		
Dibenz[a,j]acridine		IARC list Group 2A		
Dibenz[a,j]acridine (See Polycyclic Aromatic Hydrocarbons)		Reasonably Anticipated	Prop 65	IARC list 2B
Dibenz[c,h]acridine		IARC list Group 2B		
Dibenzo[a,e]pyrene (See Polycyclic Aromatic Hydrocarbons)		Reasonably Anticipated	Prop 65	
Dibenzo[a,h]pyrene (See Polycyclic Aromatic Hydrocarbons)		Reasonably Anticipated	Prop 65	IARC list 2B
Dibenzo[a,i]pyrene (See Polycyclic Aromatic Hydrocarbons)		Reasonably Anticipated	Prop 65	IARC list 2B
Dibenzo[a,l]pyrene (See Polycyclic Aromatic Hydrocarbons)		Reasonably Anticipated	Prop 65	IARC list 2A
Diborane		EPA Haz list		
Dibromoacetic acid		Prop 65		
Dibromoacetic acid		IARC list Group 2B		
Dibromoacetonitrile		IARC list 2B	Prop 65	
Dibromoacetonitrile		IARC list Group 2B		
Dichloroacetic acid		IARC list 2B	Prop 65	
dichloroacetyl-1-oxa-4-azaspiro(4,5)-decane		Prop 65		
Dichlorodiphenyltrichloroethane (DDT)		IARC list 2A	Reasonably Anticipated NTP	
Dichloroethyl ether		EPA Haz list		
Dichloromethane (Methylene Chloride)	75-09-2	Reasonably Anticipated	Prop 65	IARC list 2A
Dichloromethyl ether		Acutely Toxic		
Dichloromethylphenylsilane		EPA Haz list		
Dichlorophene		Prop 65		
Dichlorophenylarsine		Acutely Toxic		
Dichlorphenamide		Prop 65		
Dichlorvos		IARC list 2B	EPA Haz list	
Diclofop-methyl		Prop 65		
Dicrotophos		EPA Haz list		
Dicumarol		Prop 65		
Dieldrin	60-57-1	IARC list 2A	Prop 65	Acutely Toxic
Diepoxybutane		Reasonably Anticipated	Prop 65	EPA Haz list
Diesel Exhaust Particulates		Reasonably Anticipated	Prop 65	IARC list 2B
diethanolamine		Prop 65		
Diethanolamine		IARC list Group 2B		
Diethyl Chlorophosphate		EPA Haz list		
Diethyl Sulfate		Reasonably Anticipated	Prop 65	IARC list 2A
Diethylarsine		Acutely Toxic		
Diethyl-p-nitrophenyl phosphate		Acutely Toxic		
Diethylstilbestrol		KNOWN Carcinogens N	Prop 65	IARC list 1
Diflunisal		Prop 65		
Digitoxin		EPA Haz list		

Diglycidyl ether		EPA Haz list		
Diglycidyl resorcinol ether		IARC list 2B	Prop 65	Reasonably Anticipated NTP
Digoxin		IARC list 2B	EPA Haz list	
Dihydroergotamine mesylate		Prop 65		
Dihydrosafrole		IARC list 2B	Prop 65	
Di-isodecyl phthalate (DIDP)		Prop 65		
Diisononyl phthalate (DINP)		Prop 65	EPA Haz list	
Diisopropyl sulfate		IARC list 2B	Prop 65	
Diisopropylfluorophosphate (DFP)		Acutely Toxic		
Diltiazem hydrochloride		Prop 65		
Dimefox		EPA Haz list		
Dimethoate		EPA Haz list	Acutely Toxic	
Dimethyl Phosphorochloridothioate		EPA Haz list		
Dimethyl sulfate		IARC list 2A	Prop 65	Reasonably Antic EPA Haz list
Dimethylarsenic acid		IARC list 2B		
Dimethylcarbamoyl chloride		IARC list 2A	Prop 65	Reasonably Anticipated NTP
Dimethyldichlorosilane		EPA Haz list		
Dimethylhydrazine		EPA Haz list		
Dimethyl-p-Phenylenediamine		EPA Haz list		
Dimethylvinyl Chloride		Reasonably Anticipated	Prop 65	
Dimetilan		EPA Haz list	Acutely Toxic	
Di-*n*-butyl phthalate (DBP)		Prop 65		
Di-*n*-hexyl phthalate (DnHP)		Prop 65		
Dinitrocresol		EPA Haz list		
Dinitrotoluene (technical grade)		Prop 65		
Dinitrotoluene mixture, 2,4-/2,6-		Prop 65		
Dinocap		Prop 65		
Dinoseb		EPA Haz list	Prop 65	Acutely Toxic
Dinoterb		EPA Haz list		
Di-*n*-propyl isocinchomeronate (MGK Repellent 326)		Prop 65		
Dioxathion		EPA Haz list		
Diphacinone		EPA Haz list		
Diphenylhydantoin (Phenytoin)		Prop 65		
Diphenylhydantoin (Phenytoin), sodium salt		Prop 65		
Diphosphoramide, Octamethyl-		EPA Haz list	Acutely Toxic	
Diphosphoric acid, tetraethyl ester		Acutely Toxic		
Direct Black 38 (technical grade)		Prop 65		
Direct Blue 6 (technical grade)		Prop 65		
Direct Brown 95 (technical grade)		Prop 65		
Disodium cyanodithioimidocarbonate		Prop 65		
Disperse Blue 1		Reasonably Anticipated	Prop 65	IARC list 2B
Disulfoton		EPA Haz list	Acutely Toxic	
Dithiazanine Iodide		EPA Haz list		
Dithiobiuret		EPA Haz list	Acutely Toxic	
Diuron		Prop 65		
Doxorubicin hydrochloride (Adriamycin)		Prop 65		
Doxycycline (internal use)		Prop 65		

Doxycycline calcium (internal use)		Prop 65		
Doxycycline hyclate (internal use)		Prop 65		
Doxycycline monohydrate (internal use)		Prop 65		
Dyes Metabolized to 3,3´-Dimethoxybenzidine (See 3,3´-Dimethoxybenzidine and Dyes Metabolized to 3,3´-Dimethoxybenzidine)		Reasonably Anticipated	NTP	
Dyes Metabolized to 3,3´-Dimethylbenzidine (See 3,3´-Dimethylbenzidine and Dyes Metabolized to 3,3´-Dimethylbenzidine)		Reasonably Anticipated	NTP	
Dyes Metabolized to Benzidine (See Benzidine and Dyes Metabolized to Benzidine)		KNOWN Carcinogens	NTP	
Emetine, Dihydrochloride		EPA Haz list		
Emissions from combustion of coal		Prop 65		
Emissions from high-temperature unrefined rapeseed oil		Prop 65		
Endosulfan		EPA Haz list	Acutely Toxic	
Endothall		Acutely Toxic		
Endothion		EPA Haz list		
Endrin		EPA Haz list	Prop 65	Acutely Toxic
Engine exhaust, diesel		IARC list 2A		
Engine exhaust, gasoline		IARC list 2B		
Environmental tobacco smoke (ETS)		Prop 65		
Environmental Tobacco Smoke (See Tobacco Related Exposures)		KNOWN Carcinogens	NTP	
Epichlorohydrin		IARC list 2A	Prop 65	Reasonably Antic EPA Haz list
Epinephrine		Acutely Toxic		
EPN		EPA Haz list		
Epoxiconazole		Prop 65		
Epstein-Barr virus		IARC list 1	KNOWN Carcinogens NTP	
Ergocalciferol		EPA Haz list		
Ergotamine Tartrate		EPA Haz list	Prop 65	
Erionite		KNOWN Carcinogens N	Prop 65	IARC list 1
Estradiol 17B		Prop 65		
Estragole		Prop 65		
Estrogen therapy, postmenopausal		IARC list 1		
Estrogen-progestogen menopausal therapy (combined)		IARC list 1	Prop 65	
Estrogen-progestogen oral contraceptives (combined)		IARC list 1		
Estrogens, Steroidal		KNOWN Carcinogens N	Prop 65	
Estrone		Prop 65		
Estropipate		Prop 65		
Ethanedinitrile		Acutely Toxic		
Ethanesulfonyl Chloride, 2-Chloro-		EPA Haz list		
Ethanimidothioc acid, 2-(dimethylamino)-N-[[(methylamino)carbonyl]oxy]-2-oxo-, methyl ester		Acutely Toxic		
Ethanimidothioic acid,N-[[(methylamino)carbonyl]oxy]-,methyl ester		Acutely Toxic		
Ethanol in alcoholic beverages		IARC list 1	Prop 65	
Ethanol, 1,2-Dichloro-, Acetate		EPA Haz list		
Ethinylestradiol		Prop 65		
Ethion		EPA Haz list		
Ethionamide		Prop 65		
Ethoprop		Prop 65		
Ethoprophos		EPA Haz list		
Ethyl acrylate		IARC list 2B	Prop 65	
Ethyl alcohol in alcoholic beverages		Prop 65		
Ethyl carbamate (Urethane)		IARC list 2A		

Ethyl cyanide		Acutely Toxic			
Ethyl dipropylthiocarbamate		Prop 65			
Ethyl Methanesulfonate		Reasonably Anticipated	Prop 65	IARC list 2B	
Ethyl-4,4'-dichlorobenzilate		Prop 65			
Ethylbenzene		IARC list 2B	Prop 65		
Ethylbis(2-Chloroethyl)Amine		EPA Haz list			
Ethylene dibromide		IARC list 2A	Prop 65		
Ethylene dichloride (1,2-Dichloroethane)		Prop 65			
Ethylene Fluorohydrin		EPA Haz list			
Ethylene glycol (ingested)		Prop 65			
Ethylene glycol monoethyl ether		Prop 65			
Ethylene glycol monoethyl ether acetate		Prop 65			
Ethylene Oxide		KNOWN Carcinogens N	IARC list 1	Prop 65	EPA Haz list
Ethylene Thiourea		Reasonably Anticipated	Prop 65		
Ethylenediamine		EPA Haz list			
Ethyleneimine		EPA Haz list	Prop 65	Acutely Toxic	
Ethylthiocyanate		EPA Haz list			
Etodolac		Prop 65			
Etoposide		IARC list 1	Prop 65		
Etoposide in combination with cisplatin and bleomycin		IARC list 1	Prop 65		
Etretinate		Prop 65			
Famphur		Acutely Toxic			
Fenamiphos		EPA Haz list			
Fenoxaprop ethyl		Prop 65			
Fenoxycarb		Prop 65			
Fensulfothion		EPA Haz list			
Filgrastim		Prop 65			
Fission products, including strontium-90		IARC list 1			
Fluazifop butyl		Prop 65			
Fluenetil		EPA Haz list			
Flunisolide		Prop 65			
Fluorine		EPA Haz list	Acutely Toxic		
Fluoroacetamide		EPA Haz list	Acutely Toxic		
Fluoroacetic Acid		EPA Haz list	Acutely Toxic		
Fluoroacetyl Chloride		EPA Haz list			
Fluoro-edenite fibrous amphibole		IARC list 1			
Fluorouracil		EPA Haz list	Prop 65		
Fluoxymesterone		Prop 65			
Flurazepam hydrochloride		Prop 65			
Flurbiprofen		Prop 65			
Flutamide		Prop 65			
Fluticasone propionate		Prop 65			
Fluvalinate		Prop 65			
Folpet		Prop 65			
Fonofos		EPA Haz list			
Formaldehyde		IARC list 1	EPA Haz list	KNOWN Carcinogens NTP	
Formaldehyde (Gas)		Reasonably Anticipated	Prop 65		

Formaldehyde Cyanohydrin		EPA Haz list			
Formetanate Hydrochloride		EPA Haz list	Acutely Toxic		
Formothion		EPA Haz list			
Formparanate		EPA Haz list	Acutely Toxic		
Fosthietan		EPA Haz list			
Frying, emissions from high-temperature		IARC list 2A			
Fuberidazole		EPA Haz list			
Fuel oils, residual (heavy)		IARC list 2B			
Fulminic acid, mercury(2+) salt		Acutely Toxic			
Fumonisin B1		IARC list 2B	Prop 65		
Furan		Reasonably Anticipated	Prop 65	IARC list 2B	EPA Haz list
Furazolidone		Prop 65			
Furfuryl alcohol	98-00-0	IARC list 2B	Prop 65		
furilazole		Prop 65			
Furmecyclox		Prop 65			
Fusarin C		Prop 65			
Fusarium moniliforme, toxins derived from (fumonisin B1, fumonisin B2, and fusarin C)		IARC list 2B			
Gallium arsenide		Prop 65			
Gallium Trichloride		EPA Haz list			
Ganciclovir		Prop 65			
Ganciclovir sodium		Prop 65			
Gasoline		IARC list 2B	Prop 65		
Gemfibrozil		Prop 65			
Gentian violet (Crystal violet)	548-62-9	Prop 65			
Ginkgo biloba extract		IARC list 2B			
Glass wool fibers (inhalable and biopersistent)		Reasonably Anticipated	Prop 65		
Glu-P-1 (2-Amino-6-methyldipyrido[1,2- a:3',2'-d]imidazole)		Prop 65			
Glu-P-1 (2-Amino-6-methyldipyrido[1,2-a:3',2'-d]imidazole)		IARC list 2B	Prop 65		
Glu-P-2 (2-Aminodipyrido[1,2-a:3',2'-d]imidazole)		IARC list 2B			
Glycidaldehyde		IARC list 2B	Prop 65		
Glycidol		Reasonably Anticipated	Prop 65	IARC list 2A	
Glycidyl methacrylate	106-91-2	IARC list 2A			
Glyphosate	1071-83-6	IARC list 2A			
Goldenseal root powder		IARC list 2B	Prop 65		
Goserelin acetate		Prop 65			
Griseofulvin		IARC list 2B	Prop 65		
Gyromitrin (Acetaldehyde methylformylhydrazone)		Prop 65			
Haematite mining (underground)		IARC list 1			
Halazepam		Prop 65			
Halobetasol propionate		Prop 65			
Haloperidol		Prop 65			
Halothane		Prop 65			
HC Blue 1		Prop 65			
HC Blue No.		IARC list 2B			
Helicobacter pylori (infection with)		IARC list 1			
Hepatitis B Virus		KNOWN Carcinogens N	IARC list 1		
Hepatitis C Virus		KNOWN Carcinogens N	IARC list 1		

Heptachlor		IARC list 2B	Prop 65	Acutely Toxic	
Heptachlor epoxide		Prop 65			
Herbal remedies containing plant species of the genus Aristolochia		Prop 65			
n-hexane	110-54-3	Prop 65			
Hexachlorobenzene		Prop 65			
Hexachlorobenzene		Reasonably Anticipated	Prop 65	IARC list 2B	
Hexachlorobutadiene		Prop 65			
Hexachlorocyclohexane (alpha isomer)		Prop 65			
Hexachlorocyclohexane (beta isomer)		Prop 65			
Hexachlorocyclohexane (gamma isomer)		Prop 65			
Hexachlorocyclohexane (technical grade)		Prop 65			
Hexachlorocyclohexane Isomers (See Lindane and Other Hexachlorocyclohexane Isomers)		Reasonably Anticipated	IARC list 2B		
Hexachlorocyclopentadiene		EPA Haz list			
Hexachlorodibenzodioxin		Prop 65			
Hexachloroethane		Reasonably Anticipated	Prop 65	IARC list 2B	
Hexaethyl tetraphosphate		Acutely Toxic			
Hexafluoroacetone		Prop 65			
Hexamethylenediamine, N,N'-Dibutyl-		EPA Haz list			
Hexamethylphosphoramide		Reasonably Anticipated	Prop 65	IARC list 2B	
Histrelin acetate		Prop 65			
Human immunodeficiency virus type 1 (infection with)		IARC list 1	KNOWN Carcinogens NTP		
Human immunodeficiency virus type 2 (infection with)		IARC list 2B			
Human Papillomas Viruses: Some Genital-Mucosal Types		KNOWN Carcinogens NTP			
Human papillomavirus type 68		IARC list 2A			
Human papillomavirus types 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59		IARC list 1			
Human T-cell lymphotropic virus type I		IARC list 1	KNOWN Carcinogens NTP		
Hydramethylnon		Prop 65			
Hydrazine and Hydrazine Sulfate	302-01-2	Reasonably Anticipated	Prop 65	IARC list 2A	EPA Haz list
Hydrazine sulfate		Prop 65			
Hydrazinecarbothioamide		Acutely Toxic			
Hydrazobenzene		Reasonably Anticipated	Prop 65		
Hydrochlorothiazide		IARC list 2B			
Hydrocyanic Acid		EPA Haz list	Acutely Toxic		
Hydrogen Chloride (gas only)		EPA Haz list			
Hydrogen cyanide		Acutely Toxic			
Hydrogen Fluoride		EPA Haz list			
Hydrogen Peroxide (Conc > 52%)		EPA Haz list			
Hydrogen phosphide		Acutely Toxic			
Hydrogen Selenide		EPA Haz list			
Hydrogen Sulfide		EPA Haz list			
Hydroquinone		EPA Haz list			
Hydroxyurea		Prop 65			
Idarubicin hydrochloride		Prop 65			
Ifosfamide		Prop 65			
Imazalil		Prop 65			
Indeno [1,2,3-cd]pyrene		Prop 65			
Indeno[1,2,3-cd]pyrene		IARC list 2B	Reasonably Anticipated NTP		

Indium phosphide		IARC list 2A	Prop 65		
Indium tin oxide	50926-11-9	IARC list 2B			
Iodine-131		Prop 65			
Ionizing radiation (all types)		IARC list 1			
Iprodione		Prop 65			
Iprovalicarb		Prop 65			
IQ (2-Amino-3-methylimidazo[4,5-f]quinoline)		IARC list 2A	Prop 65		
Iron and steel founding (occupational exposure during)		IARC list 1			
Iron Dextran Complex		Reasonably Anticipated	Prop 65		
Iron, Pentacarbonyl-		EPA Haz list			
Iron-dextran complex		IARC list 2B			
Isobenzan		EPA Haz list			
Isobutyl nitrite		Prop 65			
Isobutyronitrile		EPA Haz list			
Isocyanic Acid, 3,4-Dichlorophenyl Ester		EPA Haz list			
Isodrin		EPA Haz list	Acutely Toxic		
Isofluorphate		EPA Haz list			
Isolan		Acutely Toxic			
Isophorone Diisocyanate		EPA Haz list			
Isoprene		Reasonably Anticipated	Prop 65	IARC list 2B	
Isopropyl alcohol manufacture using strong acids		IARC list 1			
Isopropyl Chloroformate		EPA Haz list			
Isopropylmethyl-pyrazolyl Dimethylcarbamate		EPA Haz list			
Isopyrazam		Prop 65			
Isotretinoin		Prop 65			
Isoxaflutole		Prop 65			
JC polyomavirus (JCV)		IARC list Group 2B	KNOWN Carcinogens NTP		
Kaposi sarcoma herpesvirus		IARC list 1	KNOWN Carcinogens NTP		
Kava extract		IARC list 2B			
Kepone® (Chlordecone)		Reasonably Anticipated	NTP		
Kresoxim-methyl		Prop 65			
Lactofen		Prop 65			
Lactonitrile		EPA Haz list			
Lasiocarpine		IARC list 2B	Prop 65		
Lead		IARC list 2B	Prop 65		
Lead acetate		Prop 65			
Lead and Lead Compounds		Reasonably Anticipated	Prop 65		
Lead compounds, inorganic		IARC list 2A			
Lead phosphate		Prop 65			
Lead subacetate		Prop 65			
Leather dust		IARC list 1	Prop 65		
Leptophos		EPA Haz list			
Leuprolide acetate		Prop 65			
Levodopa		Prop 65			
Levonorgestrel implants		Prop 65			
Lewisite		EPA Haz list			
Lindane and Other Hexachlorocyclohexane Isomers	58-89-9	IARC list 1	Reasonably Anticipated NT	Prop 65	EPA Haz list

Linuron		Prop 65		
Lithium carbonate		Prop 65		
Lithium citrate		Prop 65		
Lithium Hydride		EPA Haz list		
Lorazepam		Prop 65		
Lovastatin		Prop 65		
Lynestrenol		Prop 65		
Magenta		IARC list 2B		
Magenta production		IARC list 1		
Magnetic fields, extremely low-frequency		IARC list 2B		
Malaria (caused by infection with Plasmodium falciparum in holoendemic areas)		IARC list Group 2A		
Malathion	121-75-5	IARC list Group 2A	Prop 65	
Malonaldehyde, sodium salt		Prop 65		
Malononitrile		EPA Haz list		
Mancozeb		Prop 65		
Maneb		Prop 65		
Manganese dimethyldithiocarbamate.		Acutely Toxic		
Manganese, Tricarbonyl Methylcyclopentadienyl		EPA Haz list		
Manganese,bis(dimethylcarbamodithioato-S,S')-,		Acutely Toxic		
Marijuana smoke		Prop 65		
Mate, hot		IARC list 2A		
m-Cumenyl methylcarbamate.		Acutely Toxic		
m -Dinitrobenzene		Prop 65		
MeA-alpha-C (2-Amino-3-methyl-9H-pyrido[2,3-b]indole)		IARC list 2B	Prop 65	
Mebendazole		Prop 65		
Mechlorethamine		EPA Haz list		
Medroxyprogesterone acetate		IARC list 2B	Prop 65	
Megestrol acetate		Prop 65		
Melamine	108-78-1	IARC list 2B		
MeIQ (2-Amino-3,4-dimethylimidazo[4,5-f]quinoline)		IARC list 2B	Prop 65	
MeIQx (2-Amino-3,8-dimethylimidazo[4,5-f]quinoxaline)		IARC list 2B	Prop 65	
Melphalan		KNOWN Carcinogens N	Prop 65	IARC list 1
Menotropins		Prop 65		
Mepanipyrim		Prop 65		
Mephosfolan		EPA Haz list		
Meprobamate		Prop 65		
Mercaptopurine		Prop 65		
Mercuric Acetate		EPA Haz list		
Mercuric Chloride		EPA Haz list		
Mercuric Oxide		EPA Haz list		
Mercury and mercury compounds		Prop 65		
Mercury fulminate (R,T)		Acutely Toxic		
Mercury, (acetato-O)phenyl-		Acutely Toxic		
Merkel cell polyomavirus (MCV)		IARC list Group 2A	KNOWN Carcinogens NTP	
Merphalan		IARC list 2B	Prop 65	
Mestranol		Prop 65		
Metam potassium		Prop 65		

Methacrolein Diacetate		EPA Haz list		
Methacrylic Anhydride		EPA Haz list		
Methacrylonitrile		EPA Haz list		
Methacryloyl Chloride		EPA Haz list		
Methacryloyloxyethyl Isocyanate		EPA Haz list		
Methacycline hydrochloride		Prop 65		
Metham sodium		Prop 65		
Methamidophos		EPA Haz list		
Methanamine, N-methyl-N-nitroso-		Acutely Toxic		
Methane, isocyanato-		Acutely Toxic		
Methane, oxybis[chloro-		Acutely Toxic		
Methane, tetranitro- (R)		Acutely Toxic		
Methanesulfonyl Fluoride		EPA Haz list		
Methanethiol, trichloro-		Acutely Toxic		
Methanimidamide, N,N-dimethyl-N'-[3-[[(methylamino)-carbonyl]oxy]phenyl]-, monohydrochloride		Acutely Toxic		
Methanol		Prop 65		
Methazole		Prop 65		
Methidathion		EPA Haz list		
Methimazole		Prop 65		
Methiocarb		EPA Haz list	Acutely Toxic	
Methomyl		EPA Haz list	Acutely Toxic	
Methotrexate		Prop 65		
Methotrexate sodium		Prop 65		
Methoxsalen with Ultraviolet A Therapy (PUVA)		KNOWN Carcinogens N	IARC list 1	
Methoxyethylmercuric Acetate		EPA Haz list		
Methyl 2-Chloroacrylate		EPA Haz list		
Methyl Bromide		EPA Haz list	Prop 65	
Methyl carbamate		Prop 65		
Methyl chloride		Prop 65		
Methyl Chloroformate		EPA Haz list		
Methyl Hydrazine		EPA Haz list	Acutely Toxic	
Methyl iodide		Prop 65		
Methyl isobutyl ketone		Prop 65		
Methyl isobutyl ketone		IARC list Group 2B	Prop 65	
Methyl Isocyanate		EPA Haz list	Prop 65	Acutely Toxic
Methyl Isothiocyanate		EPA Haz list		
Methyl Mercaptan		EPA Haz list		
Methyl mercury		Prop 65		
Methyl Methanesulfonate		Reasonably Anticipated	Prop 65	IARC list 2A
Methyl n-butyl ketone		Prop 65		
Methyl parathion		Acutely Toxic		
Methyl Phenkapton		EPA Haz list		
Methyl Phosphonic Dichloride		EPA Haz list		
Methyl Thiocyanate		EPA Haz list		
Methyl Vinyl Ketone		EPA Haz list		
Methylarsonic acid		IARC list 2B		
Methylazoxymethanol		Prop 65		

Methylazoxymethanol acetate		IARC list 2B	Prop 65	
Methyleugenol		IARC list Group 2B	Reasonably Anticipated NT	Prop 65
Methylhydrazine and its salts		Prop 65		
Methylhydrazine sulfate		Prop 65		
Methylmercuric Dicyanamide		EPA Haz list		
Methylmercury compounds		IARC list 2B	Prop 65	
Methyltestosterone		Prop 65		
Methylthiouracil		IARC list 2B	Prop 65	
Methyltrichlorosilane		EPA Haz list		
Metiram		Prop 65		
Metolcarb		EPA Haz list	Acutely Toxic	
Metronidazole		Reasonably Anticipated	Prop 65	IARC list 2B
Mevinphos		EPA Haz list		
Mexacarbate		EPA Haz list	Acutely Toxic	
Michler´s Ketone [4,4´-(Dimethylamino)benzophenone]		Reasonably Anticipated	NTP	
Michler's base [4,4¢-methylenebis(N,N-dimethyl)-benzenamine]		IARC list 2B		
Michler's ketone [4,4¢-Bis(dimethylamino)benzophenone]		IARC list 2B	Prop 65	
Microcystin-LR		IARC list 2B		
Midazolam hydrochloride		Prop 65		
Mineral oils, untreated or mildly treated		IARC list 1	KNOWN Carcinogens NTP	
Minocycline hydrochloride (internal use)		Prop 65		
Mirex		Reasonably Anticipated	Prop 65	IARC list 2B
Misoprostol		Prop 65		
Mitomycin C		IARC list 2B	Prop 65	EPA Haz list
Mitoxantrone		IARC list 2B	Prop 65	
Molinate		Prop 65		
Molybdenum trioxide	1313-27-5	IARC list 2B		
Monocrotaline		IARC list 2B	Prop 65	
Monocrotophos		EPA Haz list		
MOPP (vincristine-prednisone-nitrogen mustard-procarbazine mixture)		Prop 65		
MOPP and other combined chemotherapy including alkylating agents		IARC list 1		
Muscimol		EPA Haz list		
Mustard Gas		KNOWN Carcinogens N	Prop 65	EPA Haz list
MX (3-chloro-4-dichloromethyl-5-hydroxy-2(5H)-furanone)		Prop 65		
Myclobutanil		Prop 65		
N,N-Bis(2-chloroethyl)-2-naphthylamine (Chlornapazine)		Prop 65		
N,N'-Diacetylbenzidine		IARC list 2B	Prop 65	
N,N-Dimethylacetamide	127-19-5	Prop 65	IARC list 2B	
N,N-Dimethylformamide	68-12-2	IARC list 2A		
N,N-Dimethylacetamide	127-19-5	Prop 65		
N,*N*-Dimethyl-*p*-toluidine	99-97-8	IARC list 2B	IARC list 2B	
N-[4-(5-Nitro-2-furyl)-2-thiazolyl]acetamide		IARC list 2B	Prop 65	
Nabam		Prop 65		
Nafarelin acetate		Prop 65		
Nafenopin		IARC list 2B	Prop 65	
Nalidixic acid		Prop 65		
Naphthalene		Reasonably Anticipated	Prop 65	IARC list 2B

N-Carboxymethyl-N-nitrosourea		Prop 65			
Neomycin sulfate (internal use)		Prop 65			
N-Ethyl-N-nitrosourea		IARC list 2A			
Netilmicin sulfate		Prop 65			
Neutrons (See Ionizing Radiation)		KNOWN Carcinogens N	IARC list 1		
Nickel (Metallic) (See Nickel Compounds and Metallic Nickel)	varies	Reasonably Anticipated	Prop 65		
Nickel acetate		Prop 65			
Nickel carbonate		Prop 65			
Nickel Carbonyl		EPA Haz list	Prop 65	Acutely Toxic	
Nickel Compounds (See Nickel Compounds and Metallic Nickel)		KNOWN Carcinogens N	Prop 65	IARC list 1	
Nickel cyanide		Acutely Toxic			
Nickel hydroxide		Prop 65			
Nickel oxide		Prop 65			
Nickel refinery dust from the pyrometallurgical process		Prop 65			
Nickel subsulfide		Prop 65			
Nickel, metallic and alloys		IARC list 2B			
Nickelocene		Prop 65			
Nicotine		EPA Haz list	Prop 65	Acutely Toxic	
Nicotine Sulfate		EPA Haz list			
Nifedipine		Prop 65			
Nimodipine		Prop 65			
Niridazole		IARC list 2B	Prop 65		
Nitrapyrin		Prop 65			
Nitrate or nitrite (ingested) under conditions that result in endogenous nitrosation		IARC list 2A			
Nitric Acid		EPA Haz list			
Nitric Oxide		EPA Haz list	Acutely Toxic		
Nitrilotriacetic acid and its salts		IARC list 2B	Prop 65	Reasonably Anticipated NTP	
Nitrilotriacetic acid, trisodium salt monohydrate		Prop 65			
Nitrobenzene		Reasonably Anticipated	Prop 65	IARC list 2B	EPA Haz list
Nitrocyclohexane		EPA Haz list			
Nitrofen (technical-grade)		IARC list 2B	Prop 65	Reasonably Anticipated NTP	
Nitrofurantoin		Prop 65			
Nitrofurazone		Prop 65			
Nitrogen Dioxide		EPA Haz list	Acutely Toxic		
Nitrogen mustard		IARC list 2A	Prop 65		
Nitrogen Mustard Hydrochloride		Reasonably Anticipated	Prop 65		
Nitrogen mustard N-oxide		IARC list 2B	Prop 65		
Nitrogen mustard N-oxide hydrochloride		Prop 65			
Nitrogen oxide NO		Acutely Toxic			
Nitroglycerine		Acutely Toxic			
Nitromethane		Reasonably Anticipated	Prop 65	IARC list 2B	
Nitrosodimethylamine		EPA Haz list			
N-Nitrosohexamethyleneimine	932-83-2	Prop 65			
Nitrous oxide		Prop 65			
N-Methyl-N´-nitro-N-nitrosoguanidine (MNNG)		IARC list 2A	Prop 65	Reasonably Anticipated NTP	
N-Methyl-N-nitrosourea		IARC list 2A			
N-Methyl-N-nitrosourethane		IARC list 2B			

N-Methylolacrylamide		Prop 65			
N-Methylpyrrolidone		Prop 65			
N-Nitrosodiethanolamine		Reasonably Anticipated	Prop 65	IARC list 2B	
N-Nitrosodiethylamine		IARC list 2A	Prop 65	Reasonably Anticipated NTP	
N-Nitrosodimethylamine		Reasonably Anticipated	Prop 65	IARC list 2A	Acutely Toxic
N-Nitrosodi-n-butylamine		IARC list 2B	Prop 65	Reasonably Anticipated NTP	
N-Nitrosodi-n-propylamine		Reasonably Anticipated	Prop 65	IARC list 2B	
N-Nitrosodiphenylamine		Prop 65			
N-Nitrosomethyl-n-butylamine		Prop 65			
N-Nitrosomethyl-n-decylamine		Prop 65			
N-Nitrosomethyl-n-dodecylamine		Prop 65			
N-Nitrosomethyl-n-heptylamine		Prop 65			
N-Nitrosomethyl-n-hexylamine		Prop 65			
N-Nitrosomethyl-n-nonylamine		Prop 65			
N-Nitrosomethyl-n-octylamine		Prop 65			
N-Nitrosomethyl-n-pentylamine		Prop 65			
N-Nitrosomethyl-n-propylamine		Prop 65			
N-Nitrosomethyl-n-tetradecylamine		Prop 65			
N-Nitrosomethyl-n-undecylamine		Prop 65			
N-Nitrosomethylethylamine		IARC list 2B	Prop 65		
N-Nitrosomethylvinylamine		Reasonably Anticipated	Prop 65	IARC list 2B	Acutely Toxic
N-Nitrosomorpholine		Reasonably Anticipated	Prop 65	IARC list 2B	
N-Nitroso-N-ethylurea		Reasonably Anticipated	Prop 65		
N-Nitroso-N-methylurea		Reasonably Anticipated	Prop 65		
N-Nitroso-N-methylurethane		Prop 65			
N-Nitrosonornicotine		Reasonably Anticipated	Prop 65		
N'-Nitrosonornicotine (NNN) and 4-(NNitrosomethylamino)-1-(3-pyridyl)-1-butanone (NNK)		IARC list 1			
N-Nitrosopiperidine		Reasonably Anticipated	Prop 65	IARC list 2B	
N-Nitrosopyrrolidine		Reasonably Anticipated	Prop 65	IARC list 2B	
N-Nitrososarcosine		Reasonably Anticipated	Prop 65	IARC list 2B	
Norbormide		EPA Haz list			
Norethisterone		Reasonably Anticipated	Prop 65		
Norethisterone (Norethindrone) /Ethinyl estradiol		Prop 65			
Norethisterone (Norethindrone) /Mestranol		Prop 65			
Norethisterone acetate (Norethindrone acetate)		Prop 65			
Norethynodrel		Prop 65			
Norgestrel		Prop 65			
O,O-Diethyl O-pyrazinyl phosphorothioate		Acutely Toxic			
o,p'-DDT		Prop 65			
o-Aminoazotoluene		Reasonably Anticipated	Prop 65		
o -Anisidine		Prop 65	EPA Haz list		
o-Anisidine Hydrochloride		Reasonably Anticipated	Prop 65		
Ochratoxin A		IARC list 2B	Prop 65	Reasonably Anticipated NTP	
Octamethylpyrophosphoramide		Acutely Toxic			
o -Dinitrobenzene		Prop 65			
Oil Orange SS		IARC list 2B	Prop 65		
o-Nitroanisole		Reasonably Anticipated	Prop 65		

o -Nitrotoluene		Prop 65	Reasonably Anticipated NTP		
o -Phenylenediamine	95-54-5	Prop 65	IARC list 2B		
o -Phenylenediamine and its salts		Prop 65			
o -Phenylenediamine dihydochloride	615-28-1	Prop 65	IARC list 2B		
o -Phenylphenate, sodium		Prop 65			
o -Phenylphenol		Prop 65			
o-Aminoazotoluene		IARC list 2B			
o-Anisidine 2B 73 1999		IARC list 2B			
o-Toluidine		IARC list 1	KNOWN Carcinogens NTP	Prop 65	
o -Toluidine hydrochloride		Prop 65			
Opisthorchis viverrini (infection with)		IARC list 1			
Oral contraceptives, combined		Prop 65			
Oral contraceptives, sequential		Prop 65			
Organorhodium Complex (PMN–82–147)		EPA Haz list			
Oryzalin		Prop 65			
Osmium tetroxide		Acutely Toxic			
Ouabain		EPA Haz list			
Oxadiazon		Prop 65			
Oxamyl		EPA Haz list	Acutely Toxic		
Oxazepam		IARC list 2B	Prop 65		
Oxetane, 3,3-Bis(Chloromethyl)-		EPA Haz list			
Oxydemeton methyl		Prop 65			
Oxydisulfoton		EPA Haz list			
Oxymetholone		Reasonably Anticipated	Prop 65		
Oxytetracycline (internal use)		Prop 65			
Oxytetracycline hydrochloride (internal use)		Prop 65			
Oxythioquinox (Chinomethionat)		Prop 65			
Ozone		EPA Haz list			
p,p'-DDT		Prop 65			
p-a,a,a- Tetrachlorotoluene		Prop 65			
Paclitaxel		Prop 65			
Palygorskite (Attapulgite) (long fibres, > 5 micrometres)		IARC list 2B	Prop 65		
p -Aminoazobenzene		Prop 65			
p-chloro-α,α,α-trifluorotoluene (para-Chlorobenzotrifluoride, PCBTF)		Prop 65			
Panfuran S (containing dihydroxymethylfuratrizine)		IARC list 2B	Prop 65		
para-Aminoazobenzene		IARC list 2B			
para-Chloroaniline		IARC list 2B			
para-Cresidine		IARC list 2B	EPA Haz list		
para-Dichlorobenzene		IARC list 2B			
para-Dimethylaminoazobenzene		IARC list 2B			
para -Nitroanisole	100-17-4	Prop 65	IARC list 2B		
Paramethadione		Prop 65			
Paraquat Dichloride		EPA Haz list			
Paraquat Methosulfate		EPA Haz list			
Parathion	56-38-2	IARC list 2B	EPA Haz list	Acutely Toxic	Prop 65
Parathion-Methyl		EPA Haz list			
Paris Green		EPA Haz list			

p-Chloroaniline		Prop 65	Acutely Toxic	
p-Chloroaniline hydrochloride		Prop 65		
p-Chloro-o-toluidine and p-Chloro-o-toluidine Hydrochloride		Reasonably Anticipated	Prop 65	
p-Chloro-*o*-toluidine, hydrochloride		Prop 65		
p-Chloro-*o*-toluidine, strong acid salts of		Prop 65		
p-Cresidine		Reasonably Anticipated	Prop 65	
p-Dichlorobenzene		Prop 65		
p-Dinitrobenzene		Prop 65		
Penicillamine		Prop 65		
Pentaborane		EPA Haz list		
pentabromodiphenyl ether mixture [DE-71 (technical grade)]		Prop 65		
Pentachlorophenol and by-products of its synthesis	87-86-5	IARC list 1	Prop 65	Reasonably Anticipated NTP
Pentadecylamine		EPA Haz list		
Pentobarbital sodium		Prop 65		
Pentosan polysulfate sodium		IARC list 2B		
Pentostatin		Prop 65		
Peracetic Acid		EPA Haz list		
Perchloromethylmercaptan		EPA Haz list		
Perfluorooctane sulfonate (PFOS)	1763-23-1	Prop 65		
Perfluorooctanoic acid (PFOA)	335-67-1	IARC list 2B	Prop 65	
Pertuzumab		Prop 65		
Petroleum refining (occupational exposures in)		IARC list 2A		
Phenacemide		Prop 65		
Phenacetin (See Phenacetin and Analgesic Mixtures Containing Phenacetin)		Reasonably Anticipated	Prop 65	IARC list 1
Phenacetin, analgesic mixtures containing		IARC list 1		
Phenazopyridine		Prop 65		
Phenazopyridine Hydrochloride		Reasonably Anticipated	Prop 65	IARC list 2B
Phenesterin		Prop 65		
Phenobarbital		IARC list 2B	Prop 65	
Phenol		EPA Haz list		
Phenol, (3,5-dimethyl-4-(methylthio)-,methylcarbamate		Acutely Toxic		
Phenol, 2-(1-methylpropyl)-4,6-dinitro-		Acutely Toxic		
Phenol, 2,2'-Thiobis(4-Chloro-6-Methyl)-		EPA Haz list		
Phenol, 2,4,6-trinitro-, ammonium salt ®		Acutely Toxic		
Phenol, 2,4-dinitro-		Acutely Toxic		
Phenol, 2-cyclohexyl-4,6-dinitro-		Acutely Toxic		
Phenol, 2-methyl-4,6-dinitro-, & salts		Acutely Toxic		
Phenol, 3-(1-Methylethyl)-, Methylcarbamate		EPA Haz list	Acutely Toxic	
Phenol, 3-methyl-5-(1-methylethyl)-,methyl carbamate.		Acutely Toxic		
Phenol, 4-(dimethylamino)-3,5-dimethyl-, methylcarbamate (ester).		Acutely Toxic		
Phenolphthalein		Reasonably Anticipated	Prop 65	IARC list 2B
Pentosan polysulfate sodium		Prop 65	IARC list 2B	
Phenoxarsine, 10,10'-Oxydi-		EPA Haz list		
Phenoxybenzamine		Prop 65		
Phenoxybenzamine Hydrochloride		Reasonably Anticipated	Prop 65	IARC list 2B
Phenprocoumon		Prop 65		
Phenyl Dichloroarsine		EPA Haz list		

Phenyl glycidyl ether		IARC list 2B	
Phenylhydrazine		Prop 65	
Phenylhydrazine and its salts		Prop 65	
Phenylhydrazine Hydrochloride		EPA Haz list	Prop 65
Phenylmercury Acetate		EPA Haz list	Acutely Toxic
Phenylphosphine		Prop 65	
Phenylsilatrane		EPA Haz list	
Phenylthiourea		EPA Haz list	Acutely Toxic
Phenytoin		Reasonably Anticipated	IARC list 2B
PhIP (2-Amino-1-methyl-6-phenylimidazo[4,5-b]pyridine)		IARC list 2B	Prop 65
Phorate		EPA Haz list	Acutely Toxic
Phosacetim		EPA Haz list	
Phosfolan		EPA Haz list	
Phosgene		EPA Haz list	Acutely Toxic
Phosphamidon		EPA Haz list	
Phosphine		EPA Haz list	Acutely Toxic
Phosphonothioic Acid, Methyl-, O-(4-Nitrophenyl) O-Phenyl Ester		EPA Haz list	
Phosphonothioic Acid, Methyl-, O-Ethyl O-(4-(Methylthio) Phenyl) Ester		EPA Haz list	
Phosphonothioic Acid, Methyl-, S-(2-(Bis(1Methylethyl)Amino)Ethyl) O-Ethyl Ester		EPA Haz list	
Phosphoric acid, diethyl 4-nitrophenylester		Acutely Toxic	
Phosphoric Acid, Dimethyl 4-(Methylthio)Phenyl Ester		EPA Haz list	
Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)ethyl] ester		Acutely Toxic	
Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)methyl] ester		Acutely Toxic	
Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester		Acutely Toxic	
Phosphorofluoridic acid, bis(1-methylethyl) ester		Acutely Toxic	
Phosphorothioic acid, O,O,-dimethyl O(4-nitrophenyl) ester		Acutely Toxic	
Phosphorothioic acid, O,O-diethyl O-(4-nitrophenyl) ester		Acutely Toxic	
Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester		Acutely Toxic	
Phosphorothioic Acid, O,O-Dimethyl-S-(2-Methylthio) Ethyl Ester		EPA Haz list	
Phosphorothioic acid,O-[4-[(dimethylamino)sulfonyl]phenyl] O,O-dimethyl ester		Acutely Toxic	
Phosphorus		EPA Haz list	
Phosphorus Oxychloride		EPA Haz list	
Phosphorus Pentachloride		EPA Haz list	
Phosphorus Trichloride		EPA Haz list	
Phosphorus-32, as phosphate		IARC list 1	
Physostigmine		EPA Haz list	Acutely Toxic
Physostigmine, Salicylate (1:1)		EPA Haz list	Acutely Toxic
Picrotoxin		EPA Haz list	
Pimozide		Prop 65	
Pioglitazone		IARC list 2B	Prop 65
Piperidine		EPA Haz list	
Pipobroman		Prop 65	
Pirimicarb		Prop 65	
Pirimifos-Ethyl		EPA Haz list	
Plicamycin		Prop 65	
Plumbane, tetraethyl-		Acutely Toxic	
Plutonium		IARC list 1	

p-Nitroaniline		Acutely Toxic			
p-Nitrosodiphenylamine		Prop 65			
Polybrominated Biphenyls (PBBs)		Reasonably Anticipated	Prop 65	IARC list 2A	
Polychlorinated Biphenyls (PCBs)		Reasonably Anticipated	Prop 65	IARC list 1	
Polychlorinated dibenzofurans		Prop 65			
Polychlorinated dibenzo-*p*-dioxins		Prop 65			
Polychlorophenols and their sodium salts		IARC list 2B			
Polycyclic Aromatic Hydrocarbons (PAHs)		Reasonably Anticipated	NTP		
Polygeenan		Prop 65			
Ponceau 3R		IARC list 2B			
Ponceau MX		Prop 65			
Ponceau MX		IARC list 2B			
Potassium Arsenite		EPA Haz list			
Potassium bromate		IARC list 2B	Prop 65		
Potassium Cyanide		EPA Haz list	Acutely Toxic		
Potassium dimethyldithiocarbamate		Prop 65			
Potassium Silver Cyanide		EPA Haz list	Acutely Toxic		
Pravastatin sodium		Prop 65			
Prednisolone sodium phosphate		Prop 65			
Primidone		IARC list 2B	Prop 65		
Procarbazine		Prop 65			
Procarbazine Hydrochloride		Reasonably Anticipated	Prop 65	IARC list 2A	
Procymidone		Prop 65			
Progesterone		Reasonably Anticipated	Prop 65		
Progestins		IARC list 2B			
Progestogen-only contraceptives		IARC list 2B			
Promecarb		EPA Haz list	Acutely Toxic		
Pronamide		Prop 65			
Propachlor		Prop 65			
Propanal, 2-methyl-2-(methyl-sulfonyl)-, O-[(methylamino)carbonyl] oxime.		Acutely Toxic			
Propanal, 2-methyl-2-(methylthio)-,O-[(methylamino)carbonyl]oxime		Acutely Toxic			
Propanenitrile		Acutely Toxic			
Propanenitrile, 2-hydroxy-2-methyl-		Acutely Toxic			
Propanenitrile, 3-chloro-		Acutely Toxic			
Propargite		Prop 65			
Propargyl alcohol		Acutely Toxic			
Propargyl Bromide (3-Bromopropyne)		EPA Haz list			
Propazine		Prop 65			
Propiolactone, Beta-		EPA Haz list			
Propionitrile		EPA Haz list			
Propionitrile, 3-Chloro-		EPA Haz list			
Propiophenone, 4-Amino-		EPA Haz list			
Propoxur		Prop 65			
Propyl Chloroformate		EPA Haz list			
Propylene glycol mono-*t*-butyl ether		Prop 65			
Propylene Oxide		Reasonably Anticipated	Prop 65	IARC list 2B	EPA Haz list
Propyleneimine		EPA Haz list			

Propylthiouracil		Reasonably Anticipated	Prop 65	IARC list 2B
Prothoate		EPA Haz list		
Pulegone		IARC list Group 2B	Prop 65	
pymetrozine		Prop 65		
Pyrene		EPA Haz list		
Pyridine	110-86-1	IARC list Group 2B	Prop 65	
Pyridine, 2-Methyl-5-Vinyl-		EPA Haz list		
Pyridine, 3-(1-methyl-2-pyrrolidinyl)-, (S)-, & salts		Acutely Toxic		
Pyridine, 4-Amino-		EPA Haz list		
Pyridine, 4-Nitro-,l-Oxide		EPA Haz list		
Pyrimethamine		Prop 65		
Pyriminil		EPA Haz list		
Pyrrolo[2,3-b]indol-5-ol,1,2,3,3a,8,8a-hexahydro-1,3a,8- trimethyl-, methylcarbamate (ester), (3aS-cis)-.		Acutely Toxic		
Quazepam		Prop 65		
Quinoline and its strong acid salts	91-22-5	IARC list Group 2B	Prop 65	
Quizalofop-ethyl		Prop 65		
Radiofrequency electromagnetic fields (Includes radiofrequency electromagnetic fields from wireless phones)		IARC list Group 2B		
Radioiodines, including iodine-131		IARC list Group 1		
Radionuclides		IARC list Group 1	Prop 65	
Radon (See Ionizing Radiation)		KNOWN Carcinogens NTP		
Reserpine		Reasonably Anticipated	Prop 65	
Residual (heavy) fuel oils		Prop 65		
Resmethrin		Prop 65		
Ribavirin		Prop 65		
Riddelliine		IARC list 2B	Prop 65	Reasonably Anticipated NTP
Rifampin		Prop 65		
S,S,S-Tributyl phosphorotrithioate		Prop 65		
Safrole		Reasonably Anticipated	Prop 65	IARC list 2B
Salcomine		EPA Haz list		
Salted fish, Chinese-style		Prop 65		
Sarin		EPA Haz list		
Schistosoma haematobium (infection with)		IARC list Group 1		
Schistosoma japonicum (infection with)		IARC list 2B		
Secobarbital sodium		Prop 65		
Sedaxane		Prop 65		
Selenious Acid		EPA Haz list		
Selenious acid, dithallium(1+) salt		Acutely Toxic		
Selenium Oxychloride		EPA Haz list		
Selenium Sulfide		Reasonably Anticipated	Prop 65	
Selenourea		Acutely Toxic		
Semicarbazide Hydrochloride		EPA Haz list		
Semustine [1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea, Methyl-CCNU]		IARC list Group 1		
Sermorelin acetate		Prop 65		
Shale oils		IARC list Group 1	Prop 65	
Silane, (4-Aminobutyl)Diethoxymethyl-		EPA Haz list		
Silica dust, crystalline, in the form of quartz or cristobalite		IARC list Group 1		
Silica, Crystalline (Respirable Size)		KNOWN Carcinogens N	Prop 65	

Silicon carbide, fibrous	308076-74-6	IARC list 2B			
Silicon carbide whiskers	409-21-2	IARC list 2A			
Silver cyanide		Acutely Toxic			
Simazine		Prop 65			
Sedaxane		Prop 65			
Smokeless Tobacco (See Tobacco Related Exposures)		KNOWN Carcinogens NTP			
Sodium Arsenate		EPA Haz list			
Sodium Arsenite		EPA Haz list			
Sodium Azide ($Na(N_3)$)		EPA Haz list	Acutely Toxic		
Sodium Cacodylate		EPA Haz list			
Sodium Cyanide (Na(CN))		EPA Haz list	Acutely Toxic		
Sodium dimethyldithiocarbamate		Prop 65			
Sodium Fluoroacetate		EPA Haz list	Prop 65		
Sodium ortho-phenylphenate		IARC list 2B			
Sodium Selenate		EPA Haz list			
Sodium Selenite		EPA Haz list			
Sodium Tellurite		EPA Haz list			
Solar Radiation (See Ultraviolet Radiation Related Exposures)		KNOWN Carcinogens N	IARC list Group 1		
Soots		KNOWN Carcinogens N	Prop 65		
Spirodiclofen		Prop 65			
Spironolactone		Prop 65			
Stannane, Acetoxytriphenyl-		EPA Haz list			
Stanozolol		Prop 65			
Sterigmatocystin		IARC list 2B	Prop 65		
Streptomycin sulfate		Prop 65			
Streptozotocin		Reasonably Anticipated	Prop 65	IARC list 2B	
Strong Inorganic Acid Mists Containing Sulfuric Acid		KNOWN Carcinogens N	Prop 65		
Strychnidin-10-one, & salts		Acutely Toxic			
Strychnidin-10-one, 2,3-dimethoxy-		Acutely Toxic			
Strychnine		EPA Haz list			
Strychnine Sulfate		EPA Haz list	Acutely Toxic		
Styrene		IARC list 2B	Reasonably Anticipated NT	Prop 65	Prop 65
Styrene oxide		Prop 65			
Styrene-7,8-oxide	96-09-3	Reasonably Anticipated	IARC list 2A		
Sulfallate		IARC list 2B	Prop 65	Reasonably Anticipated NTP	
Sulfasalazine (salicylazosulfapyridine)		IARC list 2B	Prop 65		
Sulfotep		EPA Haz list			
Sulfoxide, 3-Chloropropyl Octyl		EPA Haz list			
Sulfur Dioxide		EPA Haz list	Prop 65		
Sulfur mustard		IARC list Group 1			
Sulfur Tetrafluoride		EPA Haz list			
Sulfur Trioxide		EPA Haz list			
Sulfuric Acid		EPA Haz list	KNOWN Carcinogens NTP		
Sulfuric acid, dithallium(1+) salt		Acutely Toxic			
Sulindac		Prop 65			
Sunlamps or Sunbeds, Exposure to (See Ultraviolet Radiation Related Exposures)		KNOWN Carcinogens NTP			
Tabun		EPA Haz list			

Talc containing asbestiform fibers		Prop 65			
Tamoxifen		IARC list Group 1	Prop 65	KNOWN Carcinogens NTP	
Tamoxifen citrate		Prop 65			
Tellurium Hexafluoride		EPA Haz list			
Temazepam		Prop 65			
Teniposide		IARC list 2A	Prop 65		
TEPP		EPA Haz list			
Terbacil		Prop 65			
Terbufos		EPA Haz list			
Teriparatide		Prop 65			
Terrazole		Prop 65			
Testosterone and its esters		Prop 65			
Testosterone cypionate		Prop 65			
Testosterone enanthate		Prop 65			
Tetrabromobisphenol A	79-94-7	IARC list 2A			
Tetrachloroethylene (Perchloroethylene)		IARC list 2A	Prop 65	Reasonably Anticipated NTP	
Tetrachlorvinphos	22248-79-9	IARC list 2B	Prop 65		
Tetracycline (internal use)		Prop 65			
Tetracycline hydrochloride (internal use)		Prop 65			
Tetracyclines (internal use)		Prop 65			
Tetraethyl lead		EPA Haz list	Acutely Toxic		
Tetraethyl pyrophosphate		Acutely Toxic			
Tetraethyldithiopyrophosphate		Acutely Toxic			
Tetraethyltin		EPA Haz list			
Tetrafluoroethylene	116-14-3	Reasonably Anticipated	Prop 65	IARC list 2A	
Δ9-Tetrahydrocannabinol (Δ9-THC)	5957-75-5	Prop 65			
Tetrahydrofuran	109-99-9	IARC list 2B			
Tetramethyllead		EPA Haz list			
Tetranitromethane		Reasonably Anticipated	Prop 65	IARC list 2B	EPA Haz list
Tetraphosphoric acid, hexaethyl ester		Acutely Toxic			
Thalidomide		Prop 65			
Thallic oxide		Acutely Toxic			
Thallium Sulfate		EPA Haz list	Acutely Toxic		
Thallium(I) selenite		Acutely Toxic			
Thallous Carbonate		EPA Haz list			
Thallous Chloride		EPA Haz list			
Thallous Malonate		EPA Haz list			
Thallous Sulfate		EPA Haz list			
Thioacetamide		Reasonably Anticipated	Prop 65	IARC list 2B	
Thiocarbazide		EPA Haz list			
Thiodicarb		Prop 65			
Thiodiphosphoric acid, tetraethylester		Acutely Toxic			
Thiofanox		EPA Haz list	Acutely Toxic		
Thioguanine		Prop 65			
Thioimidodicarbonic diamide		Acutely Toxic			
Thionazin		EPA Haz list			
Thiophanate methyl		Prop 65			

Thiophenol		EPA Haz list	Acutely Toxic		
Thiosemicarbazide		EPA Haz list	Acutely Toxic		
Thiotepa		KNOWN Carcinogens N	IARC list Group 1		
Thiouracil		IARC list 2B	Prop 65		
Thiourea		Reasonably Anticipated	Prop 65		
Thiourea, (2-Chlorophenyl)-		EPA Haz list	Acutely Toxic		
Thiourea, (2-Methylphenyl)-		EPA Haz list			
Thiourea, 1-naphthalenyl-		Acutely Toxic			
Thiourea, phenyl-		Acutely Toxic			
Thorium Dioxide (See Ionizing Radiation)		KNOWN Carcinogens N	Prop 65		
Thorium-232 and its decay products		IARC list Group 1			
Tirpate		Acutely Toxic			
Titanium dioxide		IARC list 2B	Prop 65		
Titanium Tetrachloride		EPA Haz list			
Tobacco Smoking (See Tobacco Related Exposures)		KNOWN Carcinogens N	Prop 65		
Tobacco, smokeless		IARC list Group 1	Prop 65		
Tobramycin sulfate		Prop 65			
Toluene		Prop 65			
Toluene 2,4-Diisocyanate		EPA Haz list			
Toluene 2,6-Diisocyanate		EPA Haz list			
Toluene diisocyanates		IARC list 2B	Prop 65	Reasonably Anticipated NTP	
Topiramate		Prop 65			
Toxaphene		Reasonably Anticipated	Prop 65	IARC list 2B	Acutely Toxic
Toxins derived from *Fusarium moniliforme (Fusarium verticillioides)*		Prop 65			
Trans-1,4-Dichlorobutene		EPA Haz list			
trans-2-[(Dimethylamino)methylimino]-5-[2-(5-nitro-2-furyl)-vinyl]-1,3,4-oxadiazole		IARC list 2B	Prop 65		
Treosulfan		IARC list Group 1	Prop 65		
Triadimefon		Prop 65			
Triamiphos		EPA Haz list			
Triamterene		IARC list 2B			
Triazofos		EPA Haz list			
Triazolam		Prop 65			
Tributyltin methacrylate		Prop 65			
Trichlormethine (Trimustine hydrochloride)		IARC list 2B	Prop 65		
Trichloro(Chloromethyl)Silane		EPA Haz list			
Trichloro(Dichlorophenyl) Silane		EPA Haz list			
Trichloroacetic acid		IARC list 2B	Prop 65		
Trichloroacetyl Chloride		EPA Haz list			
Trichloroethylene		KNOWN Carcinogens N	Prop 65	IARC list Group 1	
Trichloroethylsilane		EPA Haz list			
Trichloromethanethiol		Acutely Toxic			
Trichloronate		EPA Haz list			
Trichlorophenylsilane		EPA Haz list			
Trientine hydrochloride		Prop 65			
Triethoxysilane		EPA Haz list			
Triforine		Prop 65			
Trilostane		Prop 65			

TRIM® VX	NA	Prop 65			
Trimethadione		Prop 65			
Trimethyl phosphate		Prop 65			
Trimethylchlorosilane		EPA Haz list			
Trimethylolpropane Phosphite		EPA Haz list			
Trimethyltin Chloride		EPA Haz list			
Trimetrexate glucuronate		Prop 65			
Triamterene		Prop 65	IARC list 2B		
Triphenyltin Chloride		EPA Haz list			
Triphenyltin hydroxide		Prop 65			
Tris(1,3-dichloro-2-propyl) phosphate (TDCPP)		Prop 65			
Tris(1-aziridinyl)phosphine sulfide (Thiotepa)		Prop 65			
tris(2,3-Dibromopropyl) Phosphate		Reasonably Anticipated	Prop 65	IARC list 2A	
Tris(2-chloroethyl) phosphate		Prop 65			
Tris(2-Chloroethyl)Amine		EPA Haz list			
Trp-P-1 (3-Amino-1,4-dimethyl-5H-pyrido[4,3-b]indole)		IARC list 2B	Prop 65		
Trp-P-2 (3-Amino-1-methyl-5H-pyrido[4,3-b]indole)		IARC list 2B	Prop 65		
Trypan blue		IARC list 2B	Prop 65		
Ultraviolet radiation (wavelengths 100-400 nm, encompassing UVA, UVB, and UVC)	NA	IARC list Group 1	KNOWN Carcinogens NTP		
Unleaded gasoline (wholly vaporized)		Prop 65			
Uracil mustard		IARC list Group 2B	Prop 65		
Urethane		Reasonably Anticipated	Prop 65		
Urofollitropin		Prop 65			
Valinomycin		EPA Haz list			
Valproate (Valproic acid)		Prop 65			
Vanadic acid, ammonium salt		Acutely Toxic			
Vanadium pentoxide		IARC list Group 2B	Prop 65	EPA Haz list	Acutely Toxic
Vinblastine sulfate		Prop 65			
Vinclozolin		Prop 65			
Vincristine sulfate		Prop 65			
Vinyl acetate		IARC list Group 2B	EPA Haz list		
Vinyl bromide		IARC list Group 2A	Prop 65	Reasonably Anticipated NTP	
Vinyl Chloride		KNOWN Carcinogens N	Prop 65	IARC list Group 1	
Vinyl cyclohexene dioxide (4-Vinyl-1-cyclohexene diepoxide)		Prop 65			
Vinylidene chloride (1,1-Dichloroethylene)	75-35-4	Prop 65	IARC list Group 2B		
Vinyl fluoride		IARC list Group 2A	Prop 65	Reasonably Anticipated NTP	
Vinyl trichloride (1,1,2-Trichloroethane)		Prop 65			
Vinylamine, N-methyl-N-nitroso-		Acutely Toxic			
Warfarin		EPA Haz list	Prop 65		
Warfarin Sodium		EPA Haz list	Acutely Toxic		
Wood dust		IARC list Group 1	Prop 65	KNOWN Carcinogens NTP	
X-Radiation and Gamma Radiation (See Ionizing Radiation		KNOWN Carcinogens N	IARC list Group 1		
Xylylene Dichloride		EPA Haz list			
Zalcitabine		IARC list Group 2B	Prop 65		
Zidovudine (AZT)		IARC list Group 2B	Prop 65		

Zileuton		Prop 65	
Zinc cyanide		Acutely Toxic	
Zinc Phosphide		EPA Haz list	Acutely Toxic
Zinc, bis(dimethylcarbamodithioato- S,S')-,		Acutely Toxic	
Zinc, Dichloro(4,4-Dimethyl-5((((Methylamino)Carbonyl) Oxy)Imino)Pentanenitrile)-, (T-4)-		EPA Haz list	
Ziram		Acutely Toxic	